The Dock & Harbour Authority

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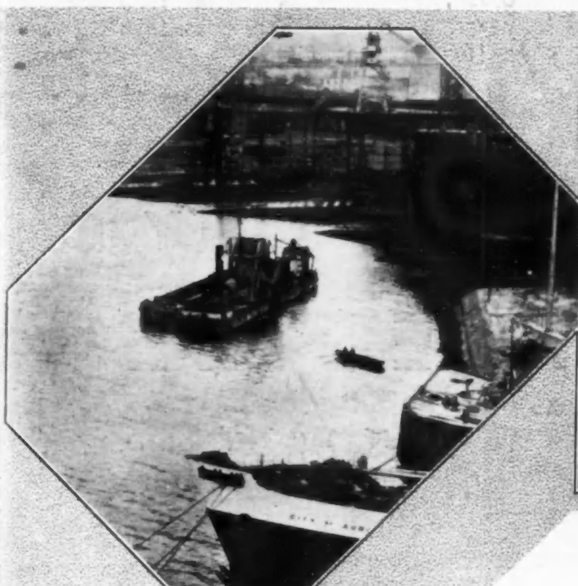

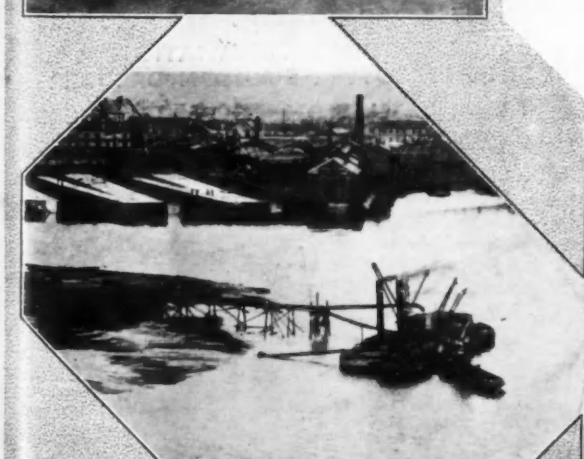
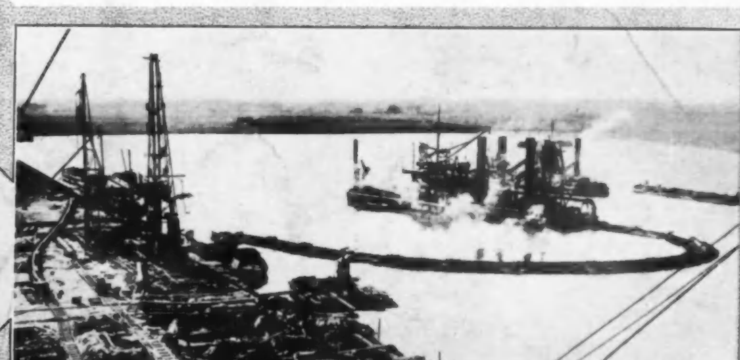

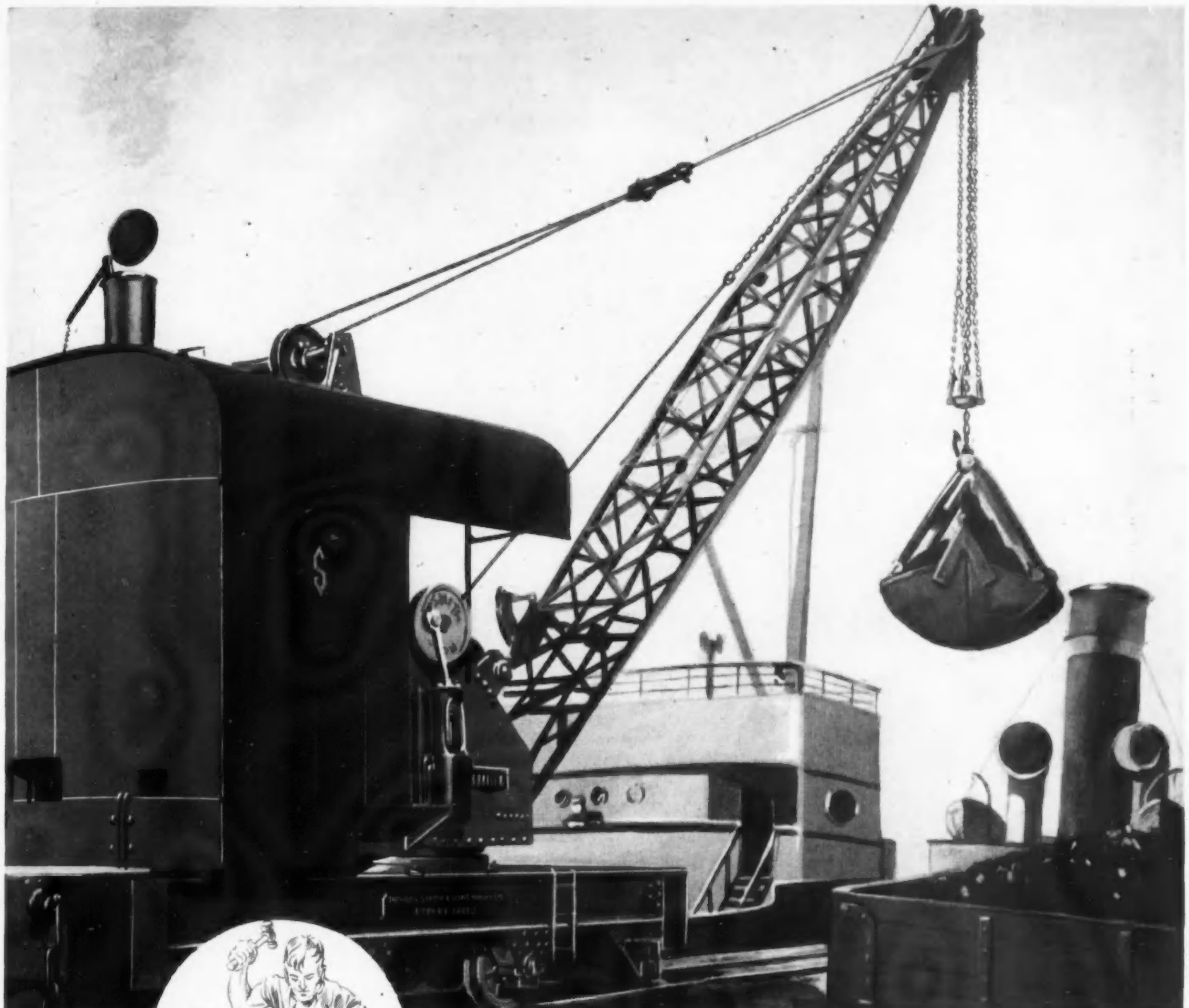

The Dock and Harbour Authority

No. 294. Vol. XXV. Edited by BRYSSON CUNNINGHAM, D.Sc. B.E., F.R.S.E., M.Inst.C.E. **April, 1945**

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Editorial Comments

Waterford: Notable Port of Eire.

To the schoolboy—and certainly to Macaulay's Schoolboy with his preternatural erudition—Waterford must always have been a place of outstanding significance and a prominent feature in his survey of Anglo-Irish relations. He learns early in the course of his historical studies that Waterford was the scene in the XIIth Century of the famous landing of the redoubtable Richard de Clare of Chepstow, surnamed Strongbow. There seems to be some little dispute whether this occurred in 1170 or 1171. Perhaps the exact date is immaterial, since there had been an earlier landing in Southern Ireland by Robert FitzStephens, to mark the incursion of Norman arms. The main point is that Strongbow, after a romantic and lightning-like courtship, married Eva, daughter of the King of Leinster, and set seal on the conquest of the country by receiving from Henry II the official appointment of Seneschal of Ireland.

As a port, Waterford has a long and distinguished record, which can be traced through the centuries in the article by Mr. A. Kane which appears in this issue. The port is approached from the sea by the winding, but well-sheltered, estuary of the River Suir. It lies at a distance of 17½ miles from the mouth of the estuary, which is three miles wide. The navigable channel, however, is impeded for navigation by three shoal patches in the bed, which have required treatment by dredging. Despite this impediment, the commerce of Waterford has developed continuously, with the occasional irregularities common to trade in general. It is the third in point of size of all ports in the Irish Free State and the main distributing centre for South-eastern Ireland.

There is a curious philological question associated with the River Suir in its approach to Waterford. Our readers are, no doubt, familiar with the proverbial expression " by hook or by crook," signifying the attainment of an object by either of alternative means or, indeed, by any means available. At first sight, the phrasing appears to be redundant—there would seem to be little, if any, difference between the two terms, both signiyfing a bent, or curved stick or staff. An etymological distinction has, indeed, been drawn, but it is not quite satisfying. Mr. Friel, the harbour engineer of Waterford, suggests that the expression originated in the fact that near the river entrance are two places, one called " Hook " on the Wexford shore, and the other on the Waterford shore, called "Crook." In the days of sailing ships, he says, shipmasters when trying to make the port against adverse winds and tides, did so by hugging one shore or the other, whichever they found more favourable for the purpose, so that these ancient mariners were accustomed to say " we shall get into port, either by Hook or by Crook." The explanation is ingenious and plausible, but we must leave it to rest on Mr. Friel's authority.

The Severn Barrage and the Severn Ports.

The eagerly awaited Report on the Severn Barrage Scheme by the three expert engineers appointed by the Minister of Fuel and Power to consider the matter has at length appeared. Curiously, there is no precise date (beyond the year of publication) affixed to the document, but it was issued to the public in the closing days (almost the closing hours) of February and was, therefore, too late for notice in our March number. Though the delay in making our comment is a little unfortunate, it has had the advantage of affording more leisured time for consideration of the Report and its implications which are undoubtedly of momentous significance, not only to electricity undertakers and power consumers, but also to the port and river authorities of the Severn and to the shipping community at large.

With the question of electrical generation and its repercussions on the economic situation and the supply of power and light throughout the country, this Journal has little or no concern, and such matters must be left for discussion in other and more competent quarters. But there are incidental and consequential effects of the scheme in regard to navigation and port accessibility on the Severn which are of vital importance to shipping and commercial interests, and these cannot be overlooked. It is necessary to give them very careful consideration.

The present committee was appointed in November, 1943 " to review the conclusions of the Severn Barrage Committee (1933) in the light of later engineering experience and practice and of other developments, and to suggest what modifications, if any, should be made in the proposed scheme, in the programme for its execution and in the estimates of its costs."

Ruling out of consideration the minor modifications (interesting only from an electrical point of view) proposed to be made in the working conditions assumed at the time of the 1933 report, it may be said that the major features of the earlier scheme are recommended to be adhered to. The site of the Barrage is still to be at the English Stones and though there is some change in sluice arrangement and capacity, and in turbine power, the general effect is the same, at any rate, as far as navigation of the river is con-

Editorial Comments—continued

cerned. In place of three navigation locks, the new scheme allows for two, which in the opinion of the committee, " will meet the requirements of the existing docks at Gloucester, Sharpness and Lydney and provide for reasonable expansions of them." It is pointed out, however, that the impounded area above the Barrage will have a tidal variation in level of 20-ft. and therefore cannot be treated as a normal wet dock. It will, in fact, be a tidal basin, the water continuously rising and falling with the corresponding stages of the tide. This does not materially alter the present conditions, except that there will be some inevitable retardation of shipping movements due to locking operations and the necessity of avoiding unsuitable " locking times." These inconveniences are not very serious and can be mitigated by the adoption of appropriate time schedules. The general effect of the turbines and sluices on the strength of the current is another factor to be taken into consideration, but here, too, careful handling of craft can overcome any difficulty.

Perhaps the most important aspect of the project is that which relates to possible physical changes in the channel and, especially from a port point of view, in the approaches to the two important ports of Bristol and Avonmouth, both lying some distance below the Barrage, but within range of its influence. The Committee of experts, apparently, are satisfied, in accordance with the views expressed by Professor Gibson in his reports of 1929 and 1932, that there will be no deterioration in the local conditions. However, they admit that there may be misgivings entertained by the authorities of the ports in question and to counter these, they put forward the suggestion that a new tidal model should be constructed and operated under the supervision of a committee of hydraulic experts on which the dock authorities would be represented. This we consider, an admirable suggestion and have little doubt that it will be acted upon.

Our views on the value of river model experiments were expressed in the last issue in a comment on the Tay Estuary model and we see no reason to doubt that Professor Gibson's conclusions respecting the effect of a Barrage on the Severn Estuary will be confirmed in the later model. Some ten years or so ago, while engaged in lecturing to engineering students at University College, London, we had frequent opportunity of visiting and studying the Rangoon River Estuary Model there, in course of construction and operation under the competent direction of Mr. Oscar Elsden, on behalf of Sir Alexander Gibb and Partners. From ocular evidence we derived a considerable degree of confidence in the use of models for determining the physical changes brought about by the intrusion of artificial works into the bed of a river.

At the same time, it is impossible not to sympathise with the attitude of the responsible port authorities on the Severn, who, on account of the tremendous issues at stake in regard to the future of their undertakings, demand to be assured with the fullest corroborative evidence that the deductions from model investigation are reliable " beyond a peradventure." River currents are curious things and strange vagaries have been experienced in their behaviour. It is on record that the navigable channel of the Mersey has drifted right across the three-mile width of the Estuary, on more than one occasion, from relatively trivial causes. It is not surprising then, that certain misgivings should be entertained respecting the reliability of small-scale model experiments, however carefully conducted; not that they are fundamentally erroneous in principle, but lest some small, but significant, factor should inadvertently have been omitted in the model, or overlooked in the interpretation of the results.

The Dock and Harbour Authorities' Association Report.

The Report of the Committee of the Dock and Harbour Authories' Association on Post-War Port Organisation, which was presented to, and approved by, the Association at its recent Annual General Meeting, has now been released for publication: it will be found on a subsequent page of this issue. It is not a very lengthy document; its chief features are an introductory statement, setting out the complexities in the problem of post-war port organisation, and a recommendation for the establishment, as soon as practicable, of an Advisory Council for the purpose of " giving advice and assistance to the Minister of War Transport in relation to questions concerning Dock, Harbour and Conservancy Authorities, and possibly Pilotage Authorities."

The Report does not advocate any specific change in the composition and functions of the existing bodies in charge of ports, though it recognises the possibility of such changes being desirable, and contemplates various directions in which changes might be made. It leaves the matter entirely open for consideration by the Advisory Council, to whom propositions may be referred by the Minister of War Transport, or by groups of authorities, or by shipping and commercial interests with certified qualifications.

The Committee's proposals in regard to the Advisory Council have commended themselves to all the constituent authorities and it will be generally felt that, on the whole, the proposals are judiciously cautious, and, at the same time, constructively helpful. Comments by shipowners, traders and other bodies are expected, and are to be submitted to the Minister.

For ourselves, with no intention of being unduly captious, we venture to make the following observations:

We would point out that members of the Advisory Council are all to be "appointed" by the Minister of War Transport, after "consultation" (with one exception) with certain bodies. Now consultation is an elastic term and it does not necessarily imply acquiescence in the advice tendered. This means that considerable power of selection is placed in the hands of the Minister, who, it is also to be noted, nominates the chairman without consultation with anybody. Moreover, there is no indication of the duration of appointment, whether for long or short period—even, it may be, at ministerial pleasure. This seems to lay the Council open to the possibility of being so constituted as to promote, to the exclusion of other interests, proposals politically inspired and emanating under Clause 3 (1) from the Minister himself. We do not affirm that this would be the case, for it is alien to British tradition to assume the intrusion of political intrigue into commercial affairs, but the possibility, though remote, is latent and we suggest, undesirable.

In Clause 2 (1) the proposed membership of the Council representative of " payers of rates, dues, charges and labour " seems to call for more precise definition. How many representatives are to be assigned to each class? and what is to prevent a single class acquiring proponderant representation, especially at times of acute political controversy?

Finally, it will be noted that the Minister is left with unfettered discretion in his treatment of the Council's recommendations. He may take action, or he may not, as he thinks fit. Can it be assumed that whatever action he decides to take will be subject to parliamentary sanction, as, for instance, in such fundamental matters as the compulsory amalgamation of ports and the drastic modification of port constitutions?

We feel that these are points which should receive consideration. Our readers may think that we have exaggerated the political aspect of the matter, to which we rejoin that the horizon is charged with portents for those who are attentive to regard them.

Merseyside Port Area.

There has been of late such a plethora of post-war schemes that the ordinary citizen is apt to receive the announcement of yet another plan with a certain degree of indifference. The importance of the district, however, precludes the adoption of this attitude towards the "Merseyside Plan, 1944,'" which has been prepared by Mr. Longstreth Thompson on the instructions of the Minister of Town and Country Planning, and has just been issued with the object of affording the local planning officers affected, as also the public, an apportunity of discussing the proposals which, it is stated, have not yet been reviewed by the Ministry or other interested departments.

The report is voluminous and sufficient time has not been available for its full consideration, so we propose to defer further notice until our next issue. Meanwhile, It may be stated that the region covered by the report is 450 square miles in extent, and covers the central group of Merseyside towns and the adjacent areas of Lancashire and Cheshire, the common interests of which are focussed on the Port of Liverpool.

The volume is obtainable from H.M. Stationery Office at the price of 7s. 6d. (inland postage, 7d.).

Waterford

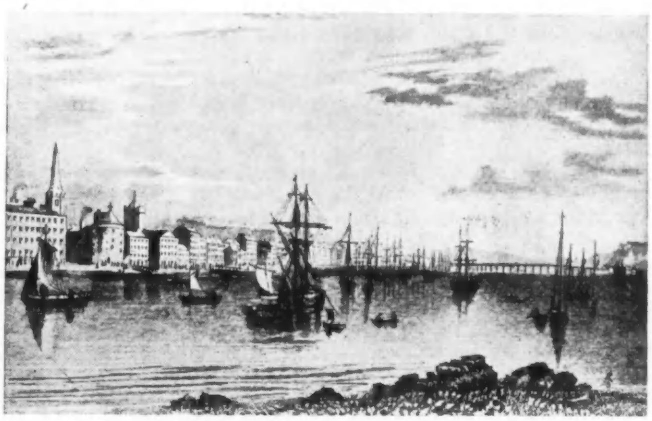
One of Ireland's Oldest Seaports

By AL KANE

Early History

AS early as the second century A.D., Waterford, situated on the South Coast of Ireland, was noted for its fine natural harbour, and can thus claim to be one of Ireland's oldest maritime cities.

In the year 155, Waterford was known as "Cuan na Grian," which means "The Harbour of the Sun." This would appear to also indicate that the pre-christian inhabitants of the district were sun worshippers. The present name, Waterford, is said to be of Scandinavian origin, and is probably a corruption of "Vader Fiord," which, translated, means "The Ford of the Father."



[Courtesy of the Waterford Harbour Commissioners].

The City of Waterford

From G. N. Wright's *Ireland Illustrated* (1829)

Like many other maritime towns of Ireland, Waterford has had a stormy history. In 853, it was attacked by the Danes, who established themselves there until the Anglo-Norman Invasion. In 995, the Danish king, Imar, making a foray from Waterford, attacked and destroyed the town of Kildare. Soon after this he succeeded Auliffe, the Danish monarch of Dublin.

Reginald's Tower, which is still in a state of good preservation, is the last remaining portion of a castle built in Waterford by Reginald, son of Imar, in 1003. Thirty-five years later the town of Waterford was burned by the King of Leinster, and in 1088 it was again destroyed, this time by the Danes of Dublin.

The Norman Invasion

Waterford was the scene of the most fateful event in the chequered history of Ireland, for it was there that, in May, 1170, following an earlier landing in Wexford in 1169, Strongbow's advance guard landed to consummate the Norman Conquest of Ireland. Four months later Strongbow himself, accompanied by 200 knights and 1,000 archers, sailed from Milford Haven and landed at Waterford. Aided by a renegade Irish prince, Strongbow successfully attacked the city, and that same evening was married to the Irish prince's daughter.

Two years later, Henry II of England came to Ireland, and landed at Waterford, where he received the formal surrender of the town from Strongbow. In 1185 John, Earl of Morton (afterwards King John) landed at Waterford and established a mint in Reginald's Tower. In 1206, after he had become King, he granted to the city an extensive charter.

A naval engagement is recorded as having taken place off Waterford when, in 1368, two neighbouring clans, the Poers and the O'Driscolls, fitted out a fleet to attack Waterford. Hearing of their coming, the Mayor, rallying the townsmen, sailed out to meet the attackers, and after a brief engagement defeated them and drove them off. The three galleys which now form part of the City's Coat of Arms, commemorates this maritime victory.

During the reign of Edward III, a gift of the Great Custom called Cocquet was granted to the citizens of Waterford for a period of ten years, the proceeds to be devoted to erecting quays and rebuilding the walls of the town.

In 1395 Richard II landed at Waterford, and granted to the town, for the same purpose as his predecessor, the duties and tolls on all goods brought into the town to be sold.

Tudor Episodes

During the rebellion of Lambert Simnel, the citizens of Waterford remained loyal to the King, despite the threats of the Pretender. For their loyalty they were thanked by the King in a letter written to them after the Battle of Stoke.

In 1497 they again maintained their loyalty against Perkin Warbeck when he came to Waterford to solicit their aid. His overtures being rejected he was forced to flee the country and was pursued by the citizens of Waterford as far as the coast of Cornwall. For this the King rewarded them by the addition to their City Arms of the motto: *Urbo Intacta Manet Waterfordia.*

The Stuart Period

During the Cromwellian War the city successfully resisted Cromwell's attempt to capture it. But the following year its defences were smashed by Ireton, who took possession of it on the 25th of July, 1650. Following the Restoration, Waterford was granted a charter by Charles II, in which the Waterford Corporation was empowered to collect dues on all goods entering or leaving the port.

It was from Waterford that, following the defeat of his army at the Battle of the Boyne, James II set sail for France. It was from there also that William of Orange set out on his return to England.

The Eighteenth Century

In 1732, and again in 1744 it is recorded that the export of corn from Waterford was held up following a number of riots there.

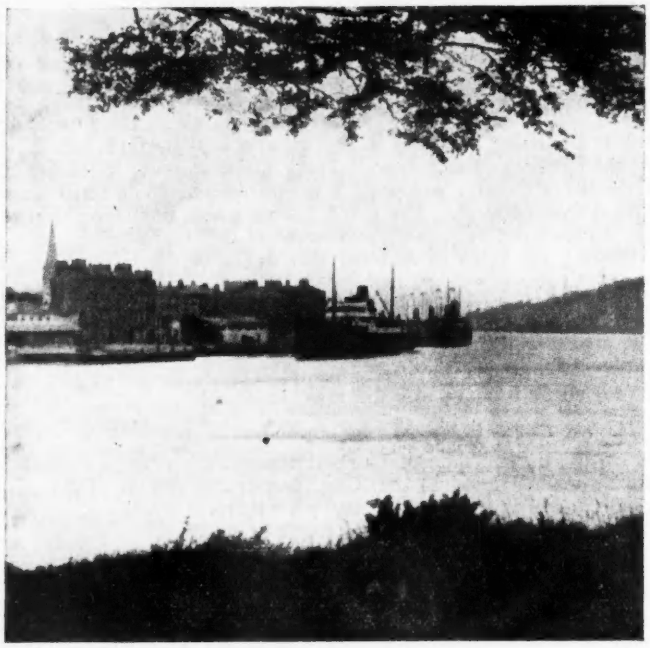
It was during that century that Waterford's commerce reached its peak point. To the ports of France, Spain, Norway, the Indies and America, the merchantmen of Waterford were frequent visitors. Newfoundland was then an important sphere of trade for Waterford vessels trading with North America and the port had an Emporium for Newfoundland goods. Some extent of Waterford's transatlantic commerce may be gleaned from the fact that no less than sixty Waterford shipowners were then sending their ships to America.

Shipbuilding Enterprise

In the 19th century Waterford developed into a great shipbuilding centre. The pioneer of this industry was Mr. Albert White, who built a slip where the largest vessels then in use could be launched. He was followed by Mr. Charles Smith, and later by the Neptune Iron Works, which was founded by Messrs. Malcolmson for the building of iron steamers. During the years 1847 to 1880 no less than forty first-class steamers were built by this firm. They also won a fine reputation for repair work, so much so that orders began to come in in such overwhelming numbers, that many of them had to be refused and passed on to the Clyde and other yards.

Waterford—continued

Many famous ships were launched at Waterford. Among them may be mentioned the ss. *Neptune*, which had the distinction of inaugurating the London—St. Petersburgh service. On the occasion of its maiden entry to the latter port, it was accorded a state welcome by Czar Nicholas I.



[Courtesy of the Waterford Harbour Commissioners].

A general view of the Port of Waterford

Harbour Surveys

It was in 1737 that the first survey of Waterford Harbour was made. This only included that portion of the river from the outer harbour to the junction of the rivers Nore, Barrow and Suir. A second and more extensive survey was made in 1794, covering the entire river up to the town. These surveys disclosed three shoal patches in the river and harbour. These were the Duncannon Shoal where the river meets the sea, where there was 13-ft. L.W.O.S.T.; the Cheekpoint Shoal, where the Nore and Barrow joined the Suir, with 12-ft. L.W.O.S.T.; and the northern channel of the Little Island, known as the Ford Channel, and which is partly artificial, which showed only 6-ft. in parts. The main river channel showed much deeper water, but was more tortuous.

Creation of Harbour Authority

In 1815 the Waterford Chamber of Commerce was formed, and in 1816 an Act was passed constituting a separate Harbour Authority for Waterford.

Up to that time a serious obstruction to the navigation of the river had been a small island which stood in the centre of the river, about two miles below the town. The channels created by the division of the river at this point were known as the Ford and the King's Channel. The depth of the Ford was 2-ft. at low water. The King's Channel, however, had sufficient depth of water to carry the largest vessels then using the port, but owing to its circuitous course, vessels required variable winds for its navigation. Furthermore, the presence of a submerged rock rendered it dangerous to shipping.

With the object of making the Ford Channel more navigable a dredger was purchased, and the depth of water was increased at a cost of £21,901, of which £14,588 was contributed by the State.

In the meantime the Acts 9th and 10th, Vic. C. 292 had been passed. Under these the former Harbour Act was repealed, and the present Harbour Commissioners constituted with much more extensive powers.

This new body comprised 24 members, 12 of whom were elected by the Chamber of Commerce, 7 by the Waterford Corporation and 5 by the Clonmel commercial community.

In order to be appointed a Commissioner it was necessary for a candidate to reside within 7 miles of Waterford or Clonmel; to have at least £800 in cash; to be clear of all lawful debts; to hold premises with a rating of at least £25 p.a. either in Waterford or Clonmel.

Dredging Operations

The first task the new body undertook was the further dredging of the river. They also erected the distinguishing towers on Newtown and Brownstown Heads at Tramore Bay. This was a work of considerable importance to shipping, as Tramore Bay had often been mistaken for Waterford, and being shallow and dangerous, had been the scene of many a shipwreck, notable among them being that of the transport *Seahorse*.

Navigation lights were also at this time erected in the harbour and along the river. The Commissioners also undertook the building of a mile long stretch of quays, which extended from the bridge to St. John's Pill. Later a number of floating pontoons were provided to enable vessels to lie afloat while discharging at the Southern Quays and a special timber and concrete wharf was also built on the south side of the river for the use of vessels engaged in the Cross-Channel trade.

On the northern bank, following the introduction of the railways, a number of timber wharves were built for general discharge and a ferro-concrete wharf, with bucket elevator for the discharge of grain.

During the same period the Commissioners also made a grant of £500 to the Board of Works for the erection of a new pier at Duncannon.

Commercial Development

In the early 19th century cotton-spinning was established in Portlaw, about a mile from Waterford. This soon developed into an extensive trade, markets being found in India, China, U.S.A., the British Colonies and all along the Pacific. Bacon-curing was also extensively carried out at Waterford, large quantities being consigned to England. Carlow butter, for which Waterford was the export port, was noted for its fine qualities, and had the distinction of always obtaining the highest prices on the London market.

[Courtesy of the Waterford Harbour Commissioners].

Cross-Channel general cargo steamers discharging at Waterford

Other exports from Waterford included beef, pork, lard, wheat, oats, barley, oatmeal, cattle, sheep, cotton manufactured goods, flour, hides, soap, glue, canvas, porter and ales. At that time

Waterford—*continued*

there were three iron foundries working in Waterford, and their products formed a considerable portion of Waterford's exports There was also a considerable trade in a cheese known as "Mullahawn," large quantities of which were exported to Newfoundland. Glass of a very superior quality was manufactured at Waterford in 1782, at Penrose's factory, later acquired by the firm of Ramsay, Gatchell & Barcroft. For this there was a considerable demand in America, and this trade continued until 1851, when, following a depression, the firm closed down and the last fires for making glass were extinguished. Waterford Glass is still highly prized by collectors.

The imports into Waterford comprised tobacco, sugar, wine, tea, coffee, hemp, tallow, pitch, tar, flax, cotton, potash, dyestuffs, timber, staves, iron, hides, saltpetre, brimstone, coal, bark, slates, tiles, etc.

Great Britain, however, was then, as now, the principal market for Irish exports. In 1813 the value of the goods imported into England from Waterford amounted to £2,200,454. The average for the three years, ending 1834, was £2,092,668.

In 1835 the number of vessels belonging to the Port of Waterford totalled 115, with a tonnage of 11,986. The Customs' duties for that year amounted to £135,845.

The following figures show the tonnage inwards and outwards from 1851 to 1854:—

Foreign Trade	British Tonnage	Foreign Tonnage	British and Coasting Tonnage
INWARDS.			
1851	15,865	14,260	166,227
1852	16,796	22,193	131.342
1853	17,071	19,472	119,475
1854	16,848	20,136	121,748
OUTWARDS.			
1851	11,235	14,023	137,953
1852	13,917	22,858	106,275
1853	11,273	18,210	101,304
1854	13,589	21,995	101,355

The amounts of customs' duties collected at the Port of Waterford during those four years were: £114,821; £101,139; £93,586, and £96,460.

Royal Visits

In 1849 Queen Victoria visited Waterford. "We entered the Waterford Harbour at 20 minutes to 4 o'clock," she wrote in her journal. "The harbour is rocky to the right as one enters, and very flat to the left. As one proceeds the land rises on either side. We found a little fort called Duncannon Fort, where James II embarked after the Battle of the Boyne, and from which they have not saluted for fifty years. Further up, between the little villages, one on either side, each with its little chapel, picturesquely situated on the top of the rock or hill, we anchored. The little fishing village on our left is called Passage, and is famous for salmon. Albert decided on going to Waterford, ten miles further up the river, in the "Fairy" with the boys, but as I felt giddy and tired I preferred to remain quietly on board sketching." The next Royal visitor to Waterford was Edward VII, who, in May, 1904, visited the town, and was shown over the Waterford Agricultural Show, which was then being held.

Channel Widening.

In 1861 a further survey of the river was decided on by the Commissioners, the task being assigned to Sir John Coode. As a result of his report the Commissioners undertook the widening of the artificial channel to 200-ft. and deepening it to 13-ft. at L.W.O.S.T. They also undertook the erection of a training guide bank, 2,000-ft. long, which, with various other works, involved a total expenditure of £50,000.

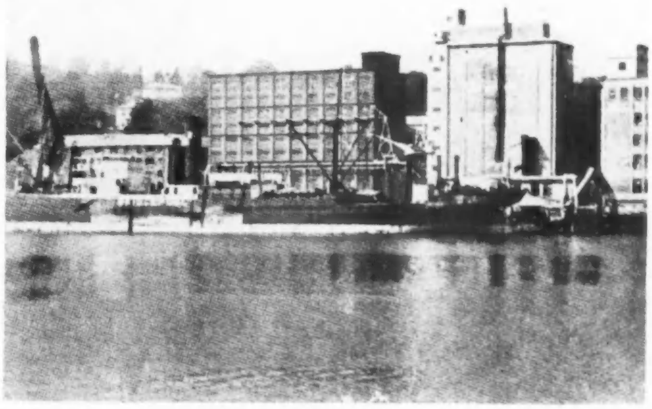
The harbour, which is situated 16 miles down river from the town, is formed by the junction of the rivers Nore, Barrow and Suir. It is entered through a deep channel, the entrance of which, from Dunmore on the west to Hook Head on the east, is 2½ miles wide.

Near the western end of Waterford's southern quay, which runs for more than a mile along the river bank, an American contractor named Cox built a wooden bridge in 1793. This bridge, which was built of Irish and American oak, and cost £30,000, connected Waterford with Ferrybank. It was in use up to 1912, when it was replaced by a modern ferro-concrete structure, 832-ft. long. The new bridge was opened by the late Mr. John E. Redmond, M.P., in February, 1913.

Recent Developments

In 1923-24 the Waterford Harbour Commissioners embarked on a huge scheme for the modernisation and improvement of the port. A wharf of reinforced concrete, 300-ft. long and 80-ft. wide, and with a 20-ton electric travelling crane, was built in order to supersede pontoons for general discharge. The old quay was increased in height and re-surfaced. The depth of the Grain Berth was increased to 25-ft., Electric lighting was also installed along the shipping quays.

Two Customs Transit sheds, measuring 200-ft. by 32-ft., were also built under this scheme for the convenience of Cross-Channel traders.



[Courtesy of the Waterford Harbour Commissioners].

A view of the s.s. "Bridgepool" discharging grain at Waterford

For the livestock trade the use of pontoons having being found very suitable, three new steel ones, with a wearing surface of natural Trinidad asphalt, were also provided.

In 1928, following a further survey of the Ford Channel, it was decided to carry out further dredging operations to obtain a minimum depth of 17-ft. at L.W.O.S.T. This was done at a cost of £22,500.

As a result of these many improvements, Waterford Harbour is now one of the finest in Eire. It is well lighted and buoyed, the lighting from the sea to Passage being under the jurisdiction of the Irish Lights Commissioners, while the lighting from Passage to Waterford is the responsibility of the Waterford Harbour Commissioners.

In the leading and guiding lights erected by the original Commissioners oil was used, but this has now been replaced by Aga Dissolved Acetylene Flashing Lights.

The tidal range at Waterford is 13½-ft. rise at spring tides, and 10¾-ft. at neaps. Waterford's largest steamer has a displacement of 6,500 tons, and a draught of 22-ft.

The port has an excellent railway service, and is the natural inlet and outlet for the south-east part of Eire. It possesses adequate facilities for the speedy loading and unloading of miscellaneous cargoes. Cranes, with capacities ranging from 5 to 20 tons, are available, and there are also elevator and suction plants for the discharging of grain.

At present Waterford's principal trade consists of the import of coal, grain, timber, artificial manures, and general cargoes. Its exports are mainly grain, pitwood, agricultural products and livestock.

Waterford—continued

According to the annual statement of the Harbour Commissioners for 1939, tne tonnage cleared at the port from 1929 to 1939 was as follows:—

	Coasting		Cross Channel		Foreign		Total	
Year	No.	Tonnage	No.	Tonnage	No.	Tonnage	No.	Tonnage
1929	590	101,451	532	283,605	57	41,173	1,179	426,229
1930	581	102,489	561	297,336	65	59,752	1,207	459,577
1931	531	94,536	544	296,742	73	68,972	1,148	460,250
1932	468	80,614	466	258,761	99	65,366	1,033	404,741
1933	342	57,994	402	226,180	149	74,477	893	358,651
1934	267	50,279	391	235,054	154	82,187	812	367,520
1935	424	77,993	419	250,248	72	51,866	915	380,107
1936	533	101,230	432	262,324	54	53,306	1,019	416,860
1937	531	93,241	462	284,699	56	59,988	1,049	437,928
1938	477	87,332	414	256,379	48	62,169	939	405,880
1939	484	95,825	399	250,778	45	57,246	928	403,849

Present conditions have, of course, adversely effected this port, and restricted developments in many directions. But the Harbour Authorities are already planning for the post-war period, and an elaborate scheme for up-to-date development of the port is already engaging their attention. When conditions permit the launching of this scheme, Waterford will become a first-class, modern and up-to-date port.

Pilotage is compulsory at Waterford, except for vessels exempt by the Pilotage Act of 1913. Other exemptions include coasting vessels not exceeding 100 tons gross tonnage, and not carrying passengers. Also exempt are tugs and tenders employed and owned locally and not carrying passengers and not navigating beyond the seaward limits of the port, provided that the Master in charge can satisfy the Authorities that he has the necessary local knowledge.

The Use of Scottish Pleasure Pier as an Emergency Port

Interesting Adaptation to War Purposes

In 1940, when Germany was desperately striving to cut off British communications by sea and endeavouring by indiscriminate bombing and the use of magnetic mines to make the East Coast ports unusable, the Ministry of War Transport decided to utilise piers on the West Coast of Scotland for unloading cargoes in order to speed up the turn-round of ships. One of those used for the purpose was Craigendoran, the Firth of Clyde pier where thousands of holidaymakers in peace-time join the London and North Eastern Railway steamers for the famous Clyde holiday resorts or for pleasure trips in the Clyde Estuary.

The adaptation of the pier to cope with war-time cargoes as well as passenger steamer traffic was not without its difficulties. A pier built for berthing shallow draught paddle steamers obviously could not accommodate the ocean-going vessels which were bringing the essential supplies to Britain. There were no suitable cranes, experienced dockers, railway lines on the pier, or facilities for moving heavy loads from the pier to rail vehicles at the nearest loading point in the adjoining passenger station.

An organisation known as the Clyde Anchorages Emergency Port was set up by the Ministry of War Transport to introduce and operate the scheme. A large fleet of shallow draught vessels was assembled to ferry the cargo from ocean steamships to the pier. These small vessels included barges brought from England and Dutch self-propelled barges manned by Dutch crews.

Electric trolleys were provided to transfer the cargoes from the pier to the adjoining passenger station for loading into rail vehicles at the platform; the structure and the road surface at the pierhead were strengthened; four electric cranes, each of 12 cwt. capacity, were installed and the necessary power was laid on. A workshop with special plant was erected for the maintenance of the trolleys and recharging of batteries. Twenty-four of the trolleys were brought from the Royal Victoria Dock on the Thames, and with them came 70 London dockers. Many of these men had never been in Scotland before and, in the early stages, they found it just as difficult to follow the Scots' tongue as the local staff did to understand the newcomers' Cockney accent.

Whilst the conversion of the pier was taking place, the London and North Eastern Railway made arrangements for dealing with the greatly-increased traffic passing by rail, involving additional staff, extra engine power and supplies of empty wagons. The first cargo—340 tons of tinned milk—was despatched from Craigendoran in 33 wagons on 11th October, 1940.

From that date, the barges plied steadily between ship and shore. Sometimes, in winter, the sea was too rough for these craft, built for inland waterways, but despite adverse weather and black-out conditions the barges in their four years' service at Craigendoran made some 4,280 journeys to and from the pier and landed over 170,000 tons of freight which was transferred to rail vehicles and dispatched to destinations all over Britain.

During the period in which Craigendoran operated as an emergency port, the London and North Eastern Railway supplied over 21,500 empty vehicles for forward loading. In many cases, special types of vehicles were required and, although war-time demands on freight rolling stock were extremely heavy, an expeditious despatch was always given to these valuable imports.

All the cargo handled was of vital importance to the nation, but one class of traffic deserves special mention because of its importance to the individual. This traffic consisted of mails from overseas, from prisoners of war, and from homes across the Atlantic to the Forces serving in Great Britain and Europe. For security reasons, landings were usually made at short notice—sometimes as brief as three or four hours—but box wagons were speedily available, loaded and rapidly transported to destinations by express trains; 154,556 bags of mail were loaded in 598 vans under the supervision of Post Office officials and dispatched by 35 special express trains in the first 11 months of 1944.

The occasion and the necessity for use as a war-time port having passed, Craigendoran Pier has once more resumed its normal functions.

Proposed Extensions at the Port of Stockholm

An address was recently given by **Mr. W. Orre,** acting manager of the Port of Stockholm to the Stockholm Shipping Club, in which he alluded to plans for the construction of a new basin at Kaknäs, adjoining the Free Port and to the proposed development of an adjacent industrial area.

Mr. Orre said that the basins in the existing port were practically completed. The most important work now in hand was the extension of the Tegelvik quay (on the south side of the Baltic outskirts of the harbour) as far as the Danvik Canal (leading to the Hammarby Harbour). This deep-water quay would be a valuable addition to the port's facilities. It only remained to provide this extension with cranes, railway tracks and storage space, and the cost of erecting a large warehouse was now being investigated. Space would also be provided for a depot for goods carried by road.

In the Free Port, filling work in the Värtan was proceeding with a view to the extension of Quays III and V, and preparatory work on a big extension to Warehouse V was being carried out. A large warehouse would soon have to be built on Quay III. The possibility of extending the Free Port in the direction of the old aerodrome was also being examined. With regard to the Kaknäs project, Mr. Orre said that a site was purchased a couple of decades ago. The scheme would probably include the provision of an industrial area for firms needing to be close to the harbour. Between Värtahamnen (chiefly used for coal and similar cargoes) and the projected Kaknäshamnen was the Loudden oil harbour, in a position which invited air attack. For this reason, as well as because regulations increasing the permissible distance between oil tanks were expected, they had put in hand an investigation into the possibilities of constructing underground tanks. It was said that the saving resulting from the prevention of leakage would alone justify the expense of providing underground tanks.

Cape Town New Graving Dock.

It has been announced by Mr. F. C. Sturrock, South African Union Minister of Transport that the new large graving dock at Cape Town will be ready for use in September next.

Notable Port Personalities

XLIX—Mr. J. Dalgleish Easton

The impending retirement is announced of **Mr. J. Dalgleish Easton,** M.Inst.C.E., M.Inst.T., from the position of Superintendent and Engineer of the Leith Docks and Clerk to the Commissioners. The retirement takes effect as from May 15th next.

Mr. Easton, whose address on the New Breakwaters at the Port of Leith, has just been published in this Journal, has been associated with many important engineering undertakings in this country and on the Continent. Before entering the service of the

Mr. J. DALGLEISH EASTON, M.Inst.C.E., M.Inst.T.

Leith Dock Commission in 1913, Mr. Easton was for many years on the staff of the late Mr. P. W. Meik, consulting civil engineer of London and Edinburgh, and was engaged on the design and construction of a number of public works, including harbours, docks, railways, and hydro-electric schemes, the earliest being the building of the second dock at Burntisland and the latest the design and construction of the hydro-electric works for the British Aluminium Company at Kinlochleven, Argyllshire, where he was resident engineer from 1905 to 1910.

Throughout the long period of his service at Leith Docks, first as chief assistant, and later in full charge, Mr. Easton has been responsible for the large number of improvements and additions which have been carried out at the port, the latest of which was the construction of the two new breakwaters above referred to and the new entrance to the harbour which have only recently been completed.

During the war Mr. Easton has been chairman of various Ministry of War Transport committees at the port in connection with shipping traffic and the storage and movement of goods, and he has also been the East of Scotland Port Representative on various committees of the Dock and Harbour Authorities' Association in London. Mr. Easton is a member of the Institute of Transport and of the Institution of Civil Engineers and chairman of the Edinburgh and District section of the latter body.

Fresh appointments on the Leith Docks Staff, consequent on Mr. Dalgleish Easton's retirement, are to be found in a Note of the Month on a later page.

Tyne Improvement Commission

Presentation of Annual Accounts

Mr. W. A. Souter, Chairman of the Finance Committee of the Tyne Improvement Commission, in presenting the accounts to the Commissioners at the Annual Meeting of the Board recently, reported that after meeting all expenditure and making full provision for interest charges and loan redemption in accordance with statutory requirements, there was only a small deficit of £591, a result which is considered extremely satisfactory. In his remarks Mr. Souter pointed out that the receipts of the Commission are the highest of any year on record.

Amongst a number of interesting points mentioned by Mr. Souter was the fact that of the Commissioners' total expenditure 40% could be looked upon as recoverable and 60% non-recoverable. A large part of the non-recoverable expenditure was represented by annual interest on and redemption of loan debt. The Commissioners are under an obligation to repay the major portion of their debt by 1958. Thereafter the interest and loan redemption charges would be so greatly reduced that a substantial reduction in dues might be possible, assuming that further additional capital obligations were not undertaken. He suggested to the Commissioners that it must be a matter of careful consideration for them to decide whether it will be a better policy to attract trade by providing additional port facilities, which means Capital Expenditure, or by reduction in dues.

The annual figures of the Commissioners reflect four outstanding items of interest: a reduction in the quantity of coal shipped, an increase in general merchandise traffic, a rise in working expenses due to increased wages and an increase in the N.B.B. dues due to the part the Tyne played in the assembly of ships and cargoes before "D" Day and as the greatest repair port in the country for the repair of vessels damaged during the invasion and by other war casualties.

Turning to the future, Mr. Souter told the Tyne Commissioners that a good deal depends upon the quantity of coal available for shipment. Coal has been an important item in the revenues of the port. He thought that there would be a heavy demand for coal from abroad, but it was difficult to predict whether the United Kingdom would be able to satisfy that demand. Favourable changes which would help in the satisfaction of the demands are—lessening of home demand for heavy industries engaged in war work; return of miners from the forces, and plans for greater modernisation and efficiency of the coal mines. Until a more settled state in industry and a larger output of coal is assured, Mr. Souter felt that the future must be a matter of anxiety for undertakings such as the Tyne Commission. He welcomed the decision of the Government to establish the Ministry of Social Security in Northumberland, which mean an increased demand in the area for food, etc., and the introduction of a section of the people with a stable income in good times and bad.

Mr. S. F. Weidner, in seconding Mr. Souter's motion, remarked that the Commissioners could consider the result of the financial operations quite satisfactory. There is, he said, a general tendency for all items of expenditure to still further increase. But for that trend, the Commissioners would have ended the year under review with possibly a substantial surplus. The increased volume of General Merchandise traffic was highly satisfactory and was reflected in the receipts from the River Dues on Goods. He hoped that some of the present class of traffic handled would find a permanent home on the Tyne.

Mr. Weidner looked forward confidently to the re-establishment of the Tyne Scandinavia and Baltic trades which are so important in the country's national welfare. The Commissioners had a big stake in the well-being of that trade and he hoped the Board would afford every assistance and inducement to further encourage and enlarge it.

Notes of the Month

German Restrictions on Danish Ports.

Restrictions, prohibiting the use of certain Danish ports by fishing and other small craft, have been imposed by the German authorities in Denmark

Improvements at Brazilian Port.

Work has been put in hand at the Port of Sao Francisco du Sul, Brazil, on extensions the authorised cost of which is limited to $33,974,000.

Clyde Lighthouses Trust.

At a recent meeting, Mr. George A. Workman, managing director of the City Line, Ltd., and vice-chairman and treasurer of the British Corporation Register of Shipping and Aircraft, was elected chairman of the Clyde Lighthouses Trustees, in succession to the late Mr. John C. Graham.

Cessation of Port Directorship.

Sir George Campbell, K.C.I.E., having relinquished his appointment as Regional Port Director for the South-Eastern Area of England and the purpose for which the Regional Port Organisation in this area (including the ports of London and Southampton) was instituted by the Minister of War Transport in the Autumn of 1943, having been accomplished, the organisation has been discontinued.

Water Inter-Communication Scheme at Hull Docks.

A scheme of water inter-communication between the Hull Docks, promoted by the Hull Chamber of Commerce, has had to be abandoned on the ground of excessive cost and its interference with the sidings accommodation of the London and North-Eastern Railway. The cost was estimated at between three and four millions sterling.

Dundee Dry Dock Project.

It is understood that the Dundee Harbour Commissioners have taken steps to approach the Secretary of State for Scotland with a view to soliciting his advice as to the best method of making application to the Board of Trade in order to further the project for a new dry dock, recently approved by the Board. The basic question is that of financing the scheme, which is estimated by the Board's engineer to cost about £620,000.

Coast Erosion at Brighton.

The Brighton Corporation are to spend £63,000 on sea defence works to the cliffs at Portobello, which, since 1932, have been eroded at the rate of 2-ft. per annum. At one point there has been a loss of 6-ft. in the past two years. The new sea defences will link up with the five-miles-long walk from Black Rock to Saltdean, which is to be reopened at Easter after long closure for national security reasons.

Death of P.L.A. Member.

We regret to record the death of Mr. Charles Edward Alexander, brother of Sir Frank Alexander, Lord Mayor of London. Mr. Alexander, who was in his 68th year, had been a member of the Port of London Authority for rather less than two years. He was on the Committee of Management of Lloyd's Register of Shipping and took an active interest in all shipping affairs.

Proposed Sea Wall for Portobello.

The building of a sea wall to prevent further damage by storms to the promenade at Portobello was discussed by Edinburgh Streets and Buildings Committee recently. The matter was raised by Councillor Fife who moved that the committee consider, as a matter of urgency, the erection of a new sea wall from the foot of James Street to connect with the promenade at Eastfield. He said that the damage being done to the promenade was causing grave concern. After discussion the matter was remitted to the City Engineer to report on the condition of the sea front at Portobello.

Murder of Port Director.

Reports in the Swedish Press indicate that Mr. F. W. H. Laub, Manager of the Copenhagen Port Authority, met his death by violence on February 16th. It is alleged in Danish circles in Stockholm that the murder was a reprisal for an act of sabotage against the German cruiser *Nurnberg* in Copenhagen Free Port. Mr. M. Blach is the new port manager.

Trade at Danish Ports.

Returns recently issued show that the income of the Port of Copenhagen, and of Danish ports as a whole, has been increased in 1943-44 over that of the previous year. Receipts at Copenhagen rose from 4,300,000 kr. to 4,700,000 kr., while expenditure remained unchanged at 4,900,000 kr. For the provincial ports, receipts amounted to 14,200,000 kr., a scompared with 13,100,000 kr. in 1942-43; while outgoings amounted to 13,700,000 kr. as against 13,100,000 kr.

New Orleans Port Board.

The term of office of Mr. Pendleton E. Lehde having expired, Mr. C. A. Bartel, formerly Vice-President, has been elected to the presidency of the Board of Commissioners of the Port of New Orleans, Louisiana, U.S.A. Mr. Bertel was appointed a member of the Board in 1940. The Board has passed a resolution commending Mr. Lehde for his constructive work in the the ports interest during his tenure of office. Mr. E. S. Binnings has been appointed a member of the Board as from January last.

Traffic in Falsterbo Canal.

Notwithstanding suspension of movements between Sweden and Germany towards the close of last year, traffic through the Falsterbo Canal (in South-west Sweden) set up a new record in 1944. The canal was used by 9,776 vessels, including 2,821 foreign vessels, compared with 8,958 vessels and 2,573 vessels respectively in 1943. No dredging was required during the year and the working costs proved surprisingly low, amounting to only about 60,000 kr. for maintenance and wages.

Condition of the Port of Bordeaux.

In a message from a special correspondent published recently in the *Front National* (Paris) a port official is reported as stating that unlike Toulon, Brest, Le Havre, and other French ports, where the cities have been destroyed and basins made useless for years to come, the port works of Bordeaux have been left almost intact. "Locks, graving docks and swing bridges are in good condition and there are now five kilometres of usable quays, with cranes, sheds and railway tracks."

Port Rivalry in Eire.

A meeting convened by the Lord Mayor was recently held in Cork to protest against the diversion of traffic by the Eire Government from the Port of Cork to the Port of Dublin. The meeting appointed a deputation to discuss the position with the Eire Minister for Supplies. A resolution was carried on the motion of the Lord Mayor declaring that all sections of the city "viewed with alarm the vanishing trade of the port and called on the Eire Government to discontinue the unfair and costly diversion of traffic and to allow to come to Cork cargoes required by the city and its hinterland, which should normally be unloaded at the port."

Leith Dock Commission.

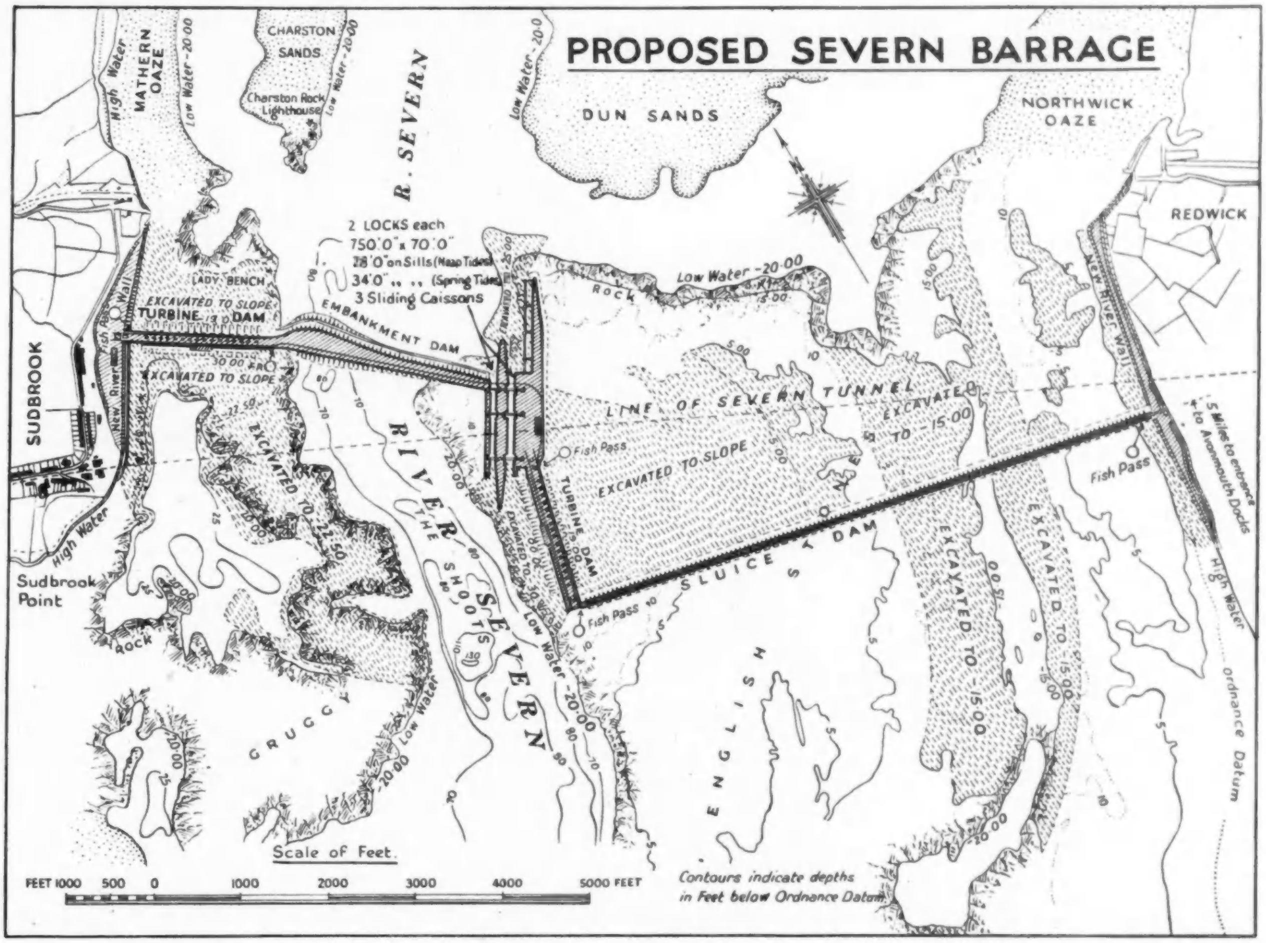
Following the retirement of Mr. J. D. Easton from the position of Clerk to the Leith Docks Commission and superintendent and engineer of the harbour, the Commissioners have appointed Mr. T. A. S. Fortune, M.Inst.C.E., M.Inst.T., to fill the vacancy. Mr. Fortune, for a number of years in the service of the Commissioners, has latterly (since 1935) been deputy superintendent and engineer, in which position he is now succeeded by Mr. J. K. Grant, B.Sc., Assoc.M.Inst.C.E. Mr. A. Balfour Kinnear, in addition to his present position as deputy clerk, has been appointed law agent to the Commissioners.

The Severn Barrage

Technical Report on Notable River Impounding Scheme

THE MINISTRY OF FUEL AND POWER has issued the Report* of the three technical experts (Mr. A. G. Vaughan-Lee, Sir William Halcrow and Mr. S. B. Donkin) reviewing the conclusions of the Severn Barrage Committee of 1933.

The following are appropriate extracts relating to those features of the scheme which affect navigation and port interests on the Severn:—



"The general principles of the layout of the 1933 Committee's Scheme, which are common also to earlier proposals, are in our opinion the right ones to adopt for the River Severn. . . .

"The layout proposed is shown on the plan herewith and is briefly as follows:—

"A sluice dam is to be constructed across 'the English Stones' containing 128 sluices. Of these 31 are to be placed at a lower level where a natural channel exists, which would be further improved by deepening. . . . This layout has the advantage of creating a stream along the Monmouth shore, which will help to minimise the deposit of silt.

* * * * *

"Two locks are provided having a length of 750-ft. and a width of 70-ft. with a depth of water on the sill of 28-ft. at neap tides and 34-ft. at spring tides. Each lock is fitted with three sliding caissons, one at each end and one in the middle. The locks may be in operation while the sluices are open and are sited so as to be clear of any current arising therefrom. During the period when the turbines are in operation, commencing a short time after high water and finishing soon after low water, the locks will not be in operation.

"We have considered the alternative of siting the locks along the Monmouth shore of the inner end of the Western turbine dam, with dredged upstream and downstream approach channels. This arrangement presents several advantages, but requires further study in co-operation with the users of the river and further investigation by tidal model. The position of the locks does not affect the Barrage power scheme as such and little, if any, additional cost would arise from this modification.

* * * * *

"The 1933 Barrage Report visualised the utilisation of the deep water basin above the Barrage as a future dock area and provided two 80-ft. locks to enable large ships to enter it, in addition to one 50-ft. lock.

"The development of this basin for accommodation of shipping is a matter of trade and policy rather than of engineering. The two 70-ft. locks proposed will meet the requirements of the existing docks at Gloucester, Sharpness and Lydney, and provide for

*H.M. Stationery Office; price 2s. 6d. net.

The Severn Barrage—continued

reasonable extensions of them. We may point out, however, that the impounded area above the Barrage will have a tidal variation of level of 20-ft. and will thus be virtually a tidal basin. It will thus compare unfavourably from an operational point of view with the large docks already existing in the Bristol Channel.

* * * * *

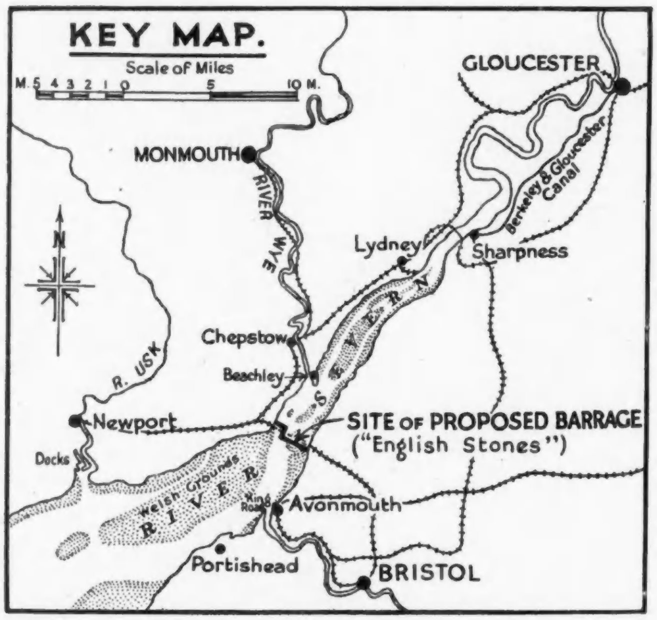
" Tidal Model—Effect of Scheme on other Interests.

" The effect of the Barrage on the river flow conditions above and below it, was dealt with comprehensively in Professor Gibson's reports of 1929 and 1932. On balance, there would be an improvement in conditions above the Barrage and adequate provision has been made in the present scheme for meeting the requireof the fishing industry. Below the dam, those responsible for the ports still fear that the alteration in the tidal flow may adversely affect their interests. They are not satisfied with the results of Professor Gibson's studies on the tidal model.

" Should it be decided to proceed with the scheme, it would be desirable to construct a new tidal model and to give the Dock Authorities the opportunity of being represented on a committee of hydraulic experts who would supervise the construction and operation of the new model.

" Some of the matters to be studied are:—

" (a) the effect of siting the locks in the alternative position referred to earlier;



" (b) silt deposit and erosion with the layout of the Barrage now proposed. The modifications appear likely to improve, rather than otherwise, the results obtained with the first model;

" (c) tidal currents in relation to the proposed temporary works and methods of construction."

Professor Gibson's Report, 1929.

In his first Report on the Construction and Operation of a Tidal Model of the Severn Estuary, it is stated by Professor Gibson in reference to the " Apparent Results of the Introduction of a Barrage," that the work then done would appear to indicate that a barrage:

" (a) would not deleteriously affect navigation *below* the barrage;

" (b) would not seriously affect navigation *above* the barrage at any time and would considerably improve it at low water even without any dredging, while with a comparatively small amount of dredging it would be at least as good at high tides and very considerably better at all other times;

" (c) would, on the whole, tend to reduce inundations in the upper estuary due to floods in the Severn."

These conclusions were approved and adopted by the expert coordinating Sub-Committee in the Appendix to the Report of the main Severn Barrage Committee (1933).

Excerpts from 1933 Report

The following general information, bearing directly on the problem, is extracted from the Appendix to the 1933 Report:—

River Depths

The Severn is navigable up to Sharpness by vessels which can enter the docks at that place, viz.: vessels of some 4,000 tons register. The factors which govern the size of vessels are: the width of entrance, which is 60-ft., and the depth over the upper sill of the lock, which is 24.5-ft. at high water springs. The longest vessel that has been docked at Sharpness is the *Seang Bee*, 444.5-ft. long, 49.1-ft. beam and 25-ft. draught. One of the largest that has been docked is the *Mottisfont*, 400.5-ft. long, 52-ft. beam and 22.6-ft. draught. The channel north-eastward between Sharpness and Gloucester is dangerous and uncertain, and is only used by small craft or at near springs. Vessels not exceeding 13-ft. draught and 190-ft. in length can, however, normally proceed to Gloucester through the Berkeley and Gloucester Ship Canal. The factors which govern the size of vessels in this case are the depth, which is normally 16-ft., from which it seldom varies more than a few inches, and the minimum width between the masonry piers of the smallest bridge, which is 34-ft.

The river has been canalised between Gloucester and Stourport, and vessels up to 250 tons can navigate to Tewkesbury and on to Worcester, a distance of 30 miles, in which length there are two locks. There are large lighters and boat docks at Worcester, with ample quayage and warehouse accommodation. Worcester is connected to Birmingham by the Worcester and Birmingham Canal. Vessels up to 110 tons can navigate to Stourport, where they enter the South Staffordshire and East Worcester canal system, which serves Kidderminster and parts of the Black Country. Vessels up to 80 tons can navigate as far as Pool Quay, near Welshpool in Montgomeryshire, 31.5 miles above Shrewsbury. Sailing vessels bound up the Severn for Chepstow, Lydney or Sharpness, usually weigh from King Road at two hours' flood. Steam vessels weigh at four to four-and-a-half hours' flood.

The Tides

High water, full and change, at Severn Bridge is about 7h. 58m., 48 minutes later than King Road. Spring tides rise 30.5-ft., neap tides 18.5-ft. The tides are much influenced by the wind; the flood stream runs for about three hours. Off Aust Cliff* the flood runs at 6 knots and the ebb 6.5 knots at spring tides; above Aust Cliff it is of uncertain and unequal rate.

At Gloucester it is high water, full and change about 9h. 45m., or 1¾ hours later than at Sharpness; springs rise about 7-ft. The duration of the flood stream at Gloucester, which is only experienced for about four days at the time of full and change, is about 1 hour, the stream continuing to set up the river 20 minutes after the water has commenced falling at Gloucester.

The Bore

The River Severn is subject to a bore, which usually begins at about 2 miles above Sharpness, but it does not form a continuous undulation from shore to shore until about Longley, 9 miles below Gloucester, where it rushes up the river with considerable noise and a front 4-ft. to 5-ft. in height. It is highest about the 5th flood stream after the full or change of the moon. The rate of the bore at first is 3.75 knots, increasing gradually to 14 knots at Rosemary, after which it decreases.

Ports on the Severn

Sharpness.—Sharpness Wet Dock, situated on the left bank of the River Severn, about 8½ miles above the mouth of the Wye, has an area of 20 acres and 12,000 cu. ft. of quayage, with

***Opposite Beachley at the Mouth of the Wye.**

The Severn Barrage—continued

depths of 24½-ft. over the upper sill of the entrance lock and in the basin.

The entrance to the dock is through a tidal basin and a lock. South pier extends about 700-ft. south-westward from the southern side of the entrance to the basin; North pier extends about 450-ft. westward from the northern side of the entrance, and then curves round sharply to the northward for a further 250-ft.

The entrance to the tidal basin is 60-ft. wide and has depths of 29-ft. over the sill at high water spring tides. The basin itself is 546-ft. long and about 250-ft. wide; it is used as a lock when vessels exceeding 300-ft. in length are being docked. The entrance lock, which lies between the tidal basin and the wet dock, is 320-ft. in length and 60-ft. in width. The lock gates are open 1.5 hours before until half-an-hour after high water.

There is a dry dock at Sharpness, the entrance of which is in the south-western corner of the wet dock; its dimensions are: length, 361½-ft.; width, 50-ft.; depth over sill, 15-ft.

Lydney.—The port consists of a tidal basin, 270-ft. by 75-ft., approached between two piers, of which the northernmost is 200-ft. in length; and of a lower and upper dock connected by a canal, three-quarters-of-a-mile in length. The basin and docks have an area of nearly 4½ acres and a quayage of 3,320-ft.; the outer basin has a depth of 24-ft. The lower docks, 780-ft. by 105-ft., and the upper 850-ft. by 88-ft. are from 12 to 14-ft. in depth; a canal, 3,400-ft. in length, 72-ft. in width and 12-ft. in depth, connects the two docks; vessels above 600 tons cannot, however, be conveniently accommodated.

Gloucester.—The Gloucester wet docks have an area of 14 acres and are connected with the river by a small lock 150-ft. long, 22-ft. 6-in. wide, with a depth of 10-ft. over sill for the passage of river craft only.

Severn Navigation

Proposals for Development

In connection with the foregoing description of the Barrage Scheme, it is appropriate to append the following report of a recent address given by **Mr. J. W. Healing,** chairman of the Severn Commission, in reference to plans for the development of the river as a commercial waterway.

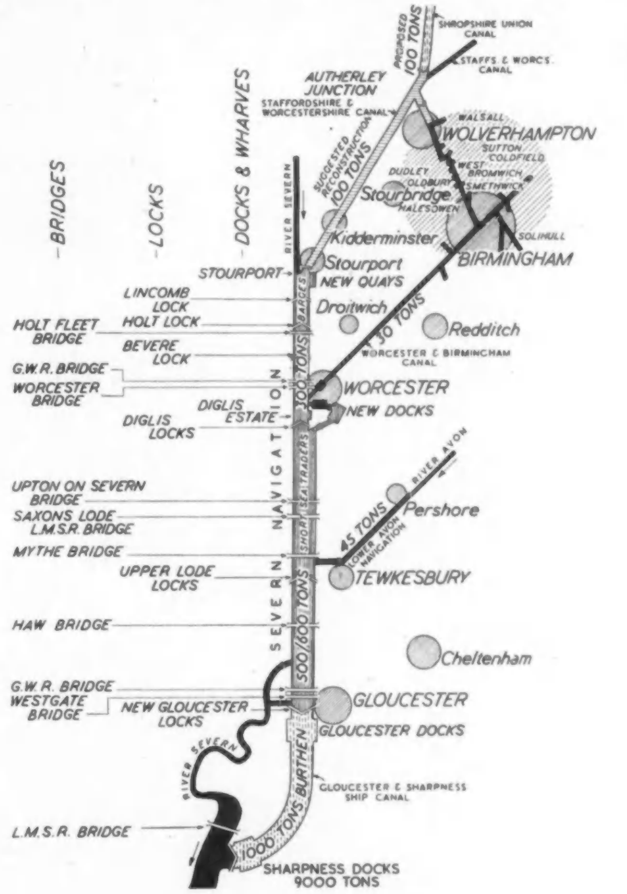
Mr. Healing said: " I believe that the River Severn should play a much greater part in the communication of the country. The Severn was a well-used waterway before the war; it has done a good job during the war, and such a splendid national and natural highway ought to take a much greater tonnage in the transportation of goods. It can be made a strong link between the Midlands and the Continent of Europe and with the Bristol Channel and other British ports. It does, in fact, bring the sea to the "doorway" of the Midlands, Worcester being 27 miles from Birmingham and Stourport 20 miles from Wolverhampton.

" The Ministry of War Transport is carrying out an examination of the project. No doubt many of you have recently read in the Press that during the House of Commons debate on Welsh affairs, the President of the Board of Trade stated that a plan was being prepared for improved navigation in the Severn which would enable larger vessels to sail up as far as Worcester and perhaps further into the Midlands. The Severn Navigation Act of 1842 and subsequent Acts have created a waterway which enables barges of 150 tons carrying capacity to travel between Stourport and the Bristol Channel, and barges of 300 tons capacity from Worcester to the Channel. Travelling up the estuary we must enter Sharpness Docks by the ship lock and use the Sharpness and Gloucester Canal, which has a capacity for boats of 1,000 tons. This gives us a 16-mile trip to Gloucester, where the Severn is rejoined by means of another lock.

" We travel up the river, passing under road and rail bridges at Gloucester, and it is not until we reach Tewkesbury that another lock is met. Proceeding to Worcester, where we lock up again through Diglis Lock, we find ourselves at the Commissioners' estate with its wharf and transit shed recently constructed with the assistance of the Ministry of War Transport. Petrol and timber interests are also represented there. Continuing up-stream for another 13 miles we reach Stourport after locking up three times. At Stourport is Severnside Estates, with its wharf, jetties and transit shed, and petrol and timber interests are again present.

Proposed Improvements

" First of all we consider that the navigation should, as far as Worcester, be enlarged to enable short sea trading vessels and



(Reproduced from *Modern Transport*)

Schematic diagram of proposed developments of the Severn Navigation.

coasters of some 600 tons carrying capacity, and specially-built craft up to 800 tons capacity, to navigate the river at all states. As far as Stourport, vessels of 300 tons capacity should be accommodated, and we suggest that the Staffordshire and Worcestershire Canal be redesigned to carry 100-ton barges as far as Autherley Junction where it joins the Shropshire Union Canal, and would therefore connect with an improved scheme proposed by the Weaver Navigation Trustees for the navigation of the Shropshire Union Canal, which would then also be able to carry barges of 100 tons capacity. This would link the navigation right through to the Mersey and Liverpool. This scheme will allow ships capable of trading with the Continent and British ports to dock in the closest proximity to the Midlands for loading and unloading, and with the larger type of barge trading to Stourport would also improve the existing communications with ports in the Bristol Channel available for Midland shipments.

" With the construction of a dock basin at Diglis, Worcester, and increased wharves and jetties at Stourport, modern handling installations, transit sheds, road and rail communication at both

The Severn Barrage—continued

places, a 'factory ship' service would in fact be provided. You may wonder when looking at the diagram, why the Worcester and Birmingham Canal has not been mentioned for improvement. This canal accommodates narrow boats of some 25-30-ton carrying capacity, and from Worcester the canal has to rise 400-ft. to reach Birmingham. The controlling body, the Gloucester and Sharpness Dock Company, has so far as I am aware no suggestion for its improvement, and it would seem that the cost of enlarging this canal system would be out of all proportion to such possible benefit as might be gained.

"What do these envisaged improvements entail? The Sharpness-Gloucester Canal would accommodate the vessels which I have just mentioned. Gloucester lock into the river will need to be reconstructed and a twin lock builit. The one for the short sea trading vessels would be 210-ft. long by 35-ft. wide and 16-ft. over the sills. The adjoining lock, 260-ft. long by 25-ft. wide and 9-ft. 6-in. over the sills, would accommodate two 300-ton Stourport boats, or the 100-ton Staffordshire and Worcestershire Canal barges. Westgate Bridge and Black Bridge carrying the railway would both have to be reconstructed to give a headroom of 40-ft., and further, to deal with the increased size of vessels, the river, for the greater part of its length, will require to be deepened and increased width given to the navigable channel. Continuing up-stream from Gloucester, we come to Haw Bridge, which will have to be reconstructed to 40-ft. headroom, and then comes Upper Lode lock at Tewkesbury, which would also have to be reconstructed to the same dimensions as the Gloucester lock. Mythe, Saxons Lode and Upton bridges must be reconstructed to provide 40-ft. headroom.

(Reproduced from *Modern Transport*)

Passage of dumb barge pushed by motor craft into one of the existing Severn locks at Diglis

"Arriving at Diglis, Worcester, we should build a dock with its lock entrance capable of accommodating the short sea traders and the large barges just below the existing lock at Diglis, which lock would have to be extended to a length of 260-ft. for the Stourport craft. Worcester bridge would require some alteration to give increased headroom, but the other bridges on the Stourport section give sufficient headroom to provide the 25-ft. required. The existing three locks at Bevere, Holt and Lincomb are inadequate and they would need reconstruction to 260-ft. long by 25-ft. wide and 9-ft. 6-in. over the sills. It is possible that these three locks could be reduced to two."

Otago (N.Z.) Harbour Board

Proposed New Dry Dock

At a recent Conference of local bodies and other civic organisations at the Port of Otago, New Zealand, **Mr. R. S. Thompson,** chairman of the Harbour Board, put forward proposals for the construction of a new dry dock at the port.

Mr. Thompson said that the usefulness of the existing Otago dock was severely restricted by its depth and width, and to a lesser degree by its length, which limited the size of vessel that could be docked to 530-ft., depending on the type of stern. The maximum draft that could be docked with 5-ft. on the tide gauge was a vessel of draft 19-ft. 6-in., beam 64-ft., while a vessel drawing 18-ft. with a beam of 6-ft. 3-in. could also be dock. A vessel with a beam of 67-ft. 3-in. could be docked on a draft 17-ft. 6-in., with only 2-in. clearance at the dock entrance, but docking a vessel with such a narrow margin would only be attempted in a case of emergency, and then only under favourable conditions.

Applying the dimensions of the dock to the vessels shown in Lloyd's Register as belonging to the principal shipping companies trading to the Dominion, Mr. Thompson said it was found that there were six shipping companies, and of the 124 vessels belonging to those companies, 47 could not be docked in the Otago dock. An examination of Lloyd's Register showed that during the latter part of 1943 and the beginning of 1944, 82 oil tankers had been built, practically all being of too wide a-beam to enter the Otago dock.

Proposed Dimensions

Mr. Thompson said that the dimensions of the proposed new dock were as follows: Length, 650-ft., capable of extension to 800-ft.; entrance width, 107-ft., and a depth on sill 30-ft. at low water. A length of 650-ft. would accommodate a very large percentage of the world's mercantile shipping, and would also accommodate the smaller type of British battleship, such as the *Royal Sovereign* and *Queen Elizabeth* class, and practically all British cruisers. An extension to 800-ft. would enable the dock to accommodate battleships of the Nelson and Rodney class and battle-cruisers of the *Repulse* and *Renown*.

Dock and Harbour Authorities' Association

Sub-Committees Appointed for 1945-47

Parliamentary and General Matters: Sir Douglas Ritchie, M.C., Mr. R. J. Hodges, Mr. M. Kissane, Mr. R. H. Jones, O.B.E., Mr. T. A. S. Fortune, Mr. J. Wilson, Mr. H. Le Mesurier, Mr. R. H. Bransbury, Mr. J. K. McKendrick, Mr. H. A. Short, Mr. F. A. Pope, Mr. Paul Gibb and Mr. L. E. Ford.

Dock and Factory Matters: Mr. Jones, Mr. Hodges, Mr. Kissane, Mr. Wilson, Mr. T. Williams, Mr. Fortune, Mr. Le Mesurier and Mr. Bransbury.

Rating and Valuation Matters: Mr. D. O. Dunlop, Mr. Bransbury and Mr. Kissane.

International Maritime Conventions: Mr. Bransbury, Mr. Le Mesurier and Mr. Roger Clayton.

Buoyage and Lighting of Coasts: Comdr. J. Whitla Gracey, R.N.R., Capt. H. V. Hart, O.B.E., R.D., R.N.R.. Capt. J. W. Eaglesome, O.B.E., Comdr. W. W. C. Frith, O.B.E., R.N.R., and Capt. A. E. Butterfield with Mr. Wilson and Mr. Bransbury added for Pilotage matters.

Post-War Port Organisation

Report of the Special Committee of the Dock and Harbour Authorities' Association

The following official statement has been issued by the Dock and Harbour Authorities' Association. As already stated, the Committee's Report was approved and adopted at the Annual General Meeting on 14th February last.

On the 10th November, 1943, the Minister of War Transport addressed a letter to the Secretary of the Association in which it was stated that if the Association had formulated any proposals in relation to the post-war organisation of Ports the Minister would be glad if they would be forwarded to him for consideration, and that as the Railway Companies had recently joined the Association the views expressed would doubtless cover both the non-railway and railway-owned Ports.

At a meeting of the Executive Committee held on the 8th of December, 1943, it was decided that a Special Committee, consisting of the General Managers of the Ports of London, Liverpool, Bristol, Manchester, Belfast, Glasgow, Leith and the Tyne, together with the General Managers of the Great Western Railway, the London Midland and Scottish Railway, the London & North Eastern Railway, and the Southern Railway, under the Chairman of the Executive Committee, be set up to formulate proposals for submission to the Minister, and report thereon to the Executive Committee.

The Special Committee now present their Report, divided into two Parts, Part 1 being a short introduction to the problems connected with organisation, and Part II defining the constitution, powers and duties of the Advisory Council which the Committee in their Report recommend should be established. As the Ports in Northern Ireland are under the Government of Northern Ireland this Report refers only to the Ports in Great Britain.

THE REPORT.

Part I: Introduction.

1. In the United Kingdom there are approximately 330 separate Ports, which fall generally into the following classes:—

Class I.—Ports managed by Public Trustees or Boards, and at which almost all of the public docks, quays and wharves are owned by them. These Ports are commonly known as Trust Ports. London, Liverpool and Glasgow are the three largest Ports in this class

In general, Trust Ports are not managed for profit, are capitalised on a loan capital basis, are managed by an Authority partly elected by the users of the Port and partly appointed by Government Departments, Local Authorities, or particular interests.

Class II.—Ports at which nearly all of the public docks, quays and wharves are owned and managed by one of the four amalgamated Railway Companies. These Ports are commonly known as the Railway-owned Ports. Hull, the Cross-Channel Ports, Southampton, Plymouth and South Wales Ports, and several other Ports are in this class.

Class III.—Ports managed by a Statutory Company other than a Railway Company, and at which all or nearly all of the public docks, quays and wharves are owned by the Company. The chief Port in this class is Manchester, which is owned and managed by the Manchester Ship Canal Company.

Class IV—Ports managed by a Local Authority or a Joint Board of Local Authorities, and at which all or nearly all of the public docks, quays and wharves are owned by them. Bristol is the chief Port in this category.

Class V.—Ports at which the public docks, quays and wharves are owned by non-statutory companies or by private individuals.

2. Of the Ports which provide accommodation for overseas or coastwise shipping, there are 43 for which separate particulars are given in Table No. 23 of the Board of Trade Annual Statement of the Navigation and Shipping of the United Kingdom. This table shows the number of net tonnage of vessels that arrived and departed (a) with cargo, and (b) with cargo and ballast from and to other countries and coastwise at each of the said 43 Ports, and aggregated in three items at the other Ports.

3. If an examination be made of the constitution, powers and duties of each Port Authority concerned in the administration of the 41 Ports in Great Britain included in the Table of Ports in the United Kingdom, it will be found that not only are there many separate Port Authorities in Great Britain, but also the powers of the individual Authorities vary greatly. At some Ports the Port Authority both owns all or nearly all the public docks, quays and wharves, and is vested with conservancy powers. At other Ports the Public docks, quays and wharves belong to one Authority, and the conservancy powers are exercised by another Authority. At some Ports the Conservancy Authority is also responsible for lighting and buoying, while at other Ports lighting and buoying services are performed by a separate Authority. At some Ports the owners of the public docks exercise many ancillary powers connected with the trade of the Port, e.g., stevedoring, warehousing, etc.

4. In considering the post-war organisation of the Port Authorities of the country major questions, each involving important subsidiary questions, would arise, such as—whether it is desirable in the public interest that the present large number of separate Port Authorities should be reduced, and if so should it be accomplished (a) by encouraging and facilitating voluntary amalgamation, or (b) by compulsory amalgamation? Is it desirable that at all Ports or at the Ports in any class or classes there should be one body only owning the public docks, quays and wharves, and should the same body also be charged with conservancy, lighting and buoying duties? It would also be necessary to consider on what principles and by what procedure amalgamation or merger of separate authorities should be effected if found to be desirable.

Further questions of great importance will require consideration when the problem of organisation is reviewed on a broad basis, for instance, whether it is desirable in the national interest, where two or more different Ports substantially serve the same area, that existing competition between the Ports should be preserved or, on the other hand, should be restricted or ended on the grounds that it leads to wasteful duplication of capital and to uneconomic concessions to individual traders or sections of trade? and whether the post-war organisation should be considered entirely on a peace basis or with a view to meeting future strategic needs?

A further matter which will have to be determined is what Authorities are to be responsible for the administration of new Ports created or developed since the outbreak of the present war.

5. In considering what, if any, advantages would accrue by amalgamating some of the Ports which serve overseas or coastwise shipping or by merging at any of these Ports the different bodies owning public docks, quays or wharves or exercising conservancy or lighting and buoying jurisdiction, it is necessary to bear in mind the three main categories of service to shipping which must be provided at every Port:—

(i) The provision and maintenance of a safe and convenient waterway between the open sea and the point of loading and discharging.

(ii) The provision of safe and suitable docks, quays and wharves for loading and discharging cargo, and for embarking and disembarking passengers.

(iii) The provision of facilities and appliances for special purposes.

It might be considered by a particular group of Ports that all the services could be provided more efficiently or more economically to the benefit of commerce or the general public by the establishment for those Ports of a single Authority, and that therefore that Authority should be established whilst, on the other hand, another group of Ports might show in relation to that group that the establishment of a like Authority would not result in any such benefit or advantage to the community, and that the services would be better provided by continuing in being the existing Port Authorities. It therefore follows that no fast or rigid formula, no yardstick, can be applied universally, and the circumstances of the several Ports or groups of Ports must first be examined by the Port or groups themselves before any definite conclusions could profitably be drawn in relation to any Port or group of Ports.

Post-War Port Organisation—continued

6. Further problems of great difficulty and complexity will arise if any attempt be made to draw a line of demarcation between the points where " services " end and " industry " begin. Furthermore, when taking into consideration the various operations performed by different Dock and Harbour Authorities which are supplemental to the three categories of service mentioned in paragraph 5 hereof it will be found that operations in different groups of docks in the same Port and under the same ownership are carried out in some cases by the owners of the docks and in others by the owners or agents of the vessels using accommodation provided by the former. It does not, however, necessarily follow that this is a disadvantage to commerce or that a uniform method of providing these services would be in the public interest.

7. In addition to the three main categories of service, reference should perhaps be made to another service, "Pilotage." Authough Pilotage is of great importance to shipowners, it is not proposed to discuss in this Report the various complications arising in connection with it, but it may be mentioned that at the two largest Ports this service is administered at London by Trinity House, who are also responsible for the lighting and buoying of the Thames and Medway estuaries, and at Liverpool by the Mersey Docks and Harbour Board. In other estuaries, such as the Bristol Channel, there are a number of different Pilotage Authorities, whilst on the Clyde, the Tees and the Tyne there are Pilotage Authorities which, as on the Thames, are bodies distinct from the Conservancy Authorities.

8. The Committee have in this Report expressed the view that no hard and fast rules can be applied in relation to post-war organisation of docks and harbours, but that the differing circumstances of the several ports or groups of ports must be considered in planning whether or not, and to what extent, reorganisation should be effected, and this view receives, perhaps, added emphasis when it is remembered that no sure predictions can be made as to the volume of post-war overseas and coastwise trade. Although this is the case, the Committee consider that it would nevertheless, be of great advantage to Ports in general if some machinery were devised first to enable the Minister of War Transport to seek advice on proposals for reorganisation, development and administration, and, secondly, to enable similar schemes initiated by the Port Authorities themselves to be set on foot.

They therefore recommend that an advisory body in the shape of an Advisory Council, to be called "The Docks and Harbours Advisory Council," should be established as soon as practicable, having the constitution and functions and being vested with the powers and duties set forth in Part II of this Report.

Part II: Advisory Council.

The Committee make the following recommendations with respect to the constitution, powers and duties of the Advisory Council, the establishment of which they recommend in Part I of this Report:—

1. An Advisory Council (to be called " the Docks and Harbours Advisory Council," and hereinafter referred to as " the Council ") to be constituted for the purpose of giving advice and assistance to the Minister of War Transport in relation to questions concerning Dock, Harbour and Conservancy Authorities, and possibly Pilotage Authorities.

2. (1) The Council to consist of 13 members appointed by the Minister, as follows:—

A Chairman.

Six members representing Dock, Harbour and Conservancy Authorities, and appointed after consultation with the Dock and Harbour Authorities' Association.

Six members representing payers of rates, dues, charges and labour at Ports and Municipal and Local Authorities appointed after consultation with the General Council of Shipping, the Association of British Chambers of Commerce, the Association of Municipal Corporations, and the Scottish Convention of Royal Burghs, and such organisations representative of labour as the Minister thinks best qualified to advise him upon the matter.

(2) The Council to have power to regulate its own procedure.

(3) The Council to give notice to any Authority in respect of which any proposals relating to that Authority's undertaking have been submitted to the Council, and permit a representative of any such Authority to attend any meetings of the Council at which such proposals are examined, and have a proper opportunity to represent his case.

3. The Council shall examine and report to the Minister on:—

(1) Any proposals which may be submitted to the Council by the Minister.

(2) Any proposals which may be submitted by two or more Dock, Harbour or Conservancy Authorities relating to the amalgamation, co-ordination, improvement or development of the undertakings of the several Authorities so submitting the proposals.

(3) Any matters affecting Dock, Harbour, Conservancy or cognate Authorities which may be submitted to the Council for its advice and report by the Dock and Harbour Authorities' Association on behalf of such Authorities, or by any group or groups of such Authorities in relation to particular undertakings in that group of those groups.

(4) Any proposals which may be submitted to the Council by any Chamber of Commerce or Shipping, or by any other Association interested in the trade of the United Kingdom which obtains a certificate from the Board of Trade that it is a proper body to make such proposals relating to:—

(i) the amalgamation or co-ordination of any Dock, Harbour, Conservancy or cognate Authorities;

(ii) the provision, improvement and development of facilities for loading, unloading or warehousing goods at Ports.

4. Every report made by the Council on any proposals or matters submitted to it shall be made to the Minister, and a copy thereof sent by the Council to the body or bodies by whom the submission was made, and to any body or bodies affected thereby.

February, 1945.

Dockside Thefts

Anti-Pilferage Measures at Manchester

On the initiative of the "Loss and Damage to Imports" Committee of the Manchester Steamship Owners' Association, with the approval of the North-Western Regional Port Director, the following notice has been circulated to all concerned.

" As an anti-pilferage measure it has been arranged, in agreement with the Regional Port Director, that the police on duty at any of the Manchester dock entrance gates may stop road vehicles leaving the docks and direct the vehicle to a nearby berth where the Manchester Ship Canal Company will provide the necessary men and appliances to unload the vehicle as may be necessary to satisfy the police, afterwards reloading it.

" The load on the vehicle will be checked with the dock pass held by the police and, if they are satisfied, the vehicle will be allowed to leave the docks immediately. In the event, however, of any discrepancy, the dock labour superintendent or his representative will be called in and the police will decide upon the action to be taken before the vehicle is allowed to leave the docks.

" The account for the cost involved in lightening and re-loading the vehicle will be sent by the Ship Canal Company to the shipowner or agent from whose ship the cargo in question was discharged.

" Shipowners or agents are required to make occasional check weighings of packages received for export, and any expenses incurred by the Ship Canal Company for such weighings shall be rendered to the shipowner or agent."

*Pile Drivers**

By D. C. BEAN, B.Sc., Assoc.M.Inst.C.E.*

Introduction

COMMONLY the term " pile driver " is applied to a tower-like structure called a " pile frame " equipped with a hammer to drive the pile and a winch to lift the hammer.

The pile frame must be of sufficient height to raise the hammer directly above the pile to be driven ; it serves to locate the pile in the desired position and guide it during the initial stages of penetration, and to guide the hammer during its descent. The winch, generally power-operated, controls the hammer and may also be used for handling the pile. Ability to lift the pile is not an essential feature of a pile driver, as some outside agency such as a derrick crane may be used to place or " pitch " the pile into the leaders or guides for the hammer and pile to support sheaves which guide the operating ropes over the head of the frame. There are generally three head-sheaves, one placed centrally to guide the hammer rope, the other two being offset on either side to provide alternative positions for the pile pitching rope. Pile frames are usually mounted on four swivelling rail wheels with self-contained jacking screws which enable the frame to be plumbed on uneven ground, the swivelling wheels allowing the plant to be turned. Frames may also be supported on tubular rollers in turn being supported on heavy timber baulks. Rail wheel mounting is quick and convenient when piles have to be driven in lines, but roller mounting gives greater freedom of movement and more

Fig. 1. Standard Pile Frame

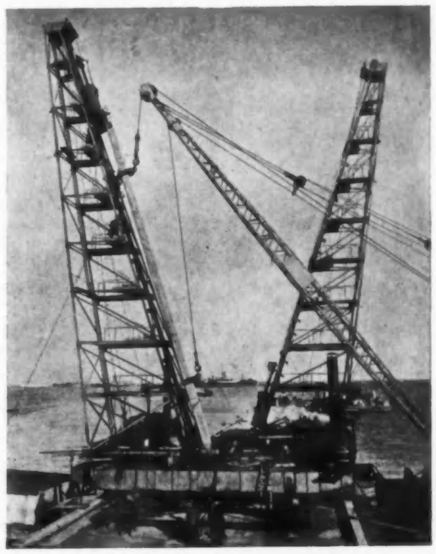


Fig. 2. Two Fixed Rake Pile Frames

Fig. 3. Raking Pile Frame

the guides or " leaders " of the frame. Automatic hammers actuated by steam or by compressed air may be used without a pile frame so long as some other means exists for lifting them ; and since these automatic hammers apply the necessary force to the piles they are also pile drivers.

Timber frames and drop hammers, little different from the earliest pile drivers, are still used on small works ; but the modern pile driver of any size is a power-operated machine of steel construction designed specially for the many operations it has to perform. Motive power may be steam, petrol, oil, or electricity, the choice being largely a matter of convenience.

The notes and illustrations in this paper are of British practice. Continental practice is largely similar. Some well-known makes of hammers originated in America, where pile-driving methods are also similar excepting that hammers are operated between the guides of a pile frame instead of on the face of the guides as in this country. The comparative methods of the two systems has been debated for many years. In America more use is made of mobile cranes and less of complete pile-driving plants.

Pile Frames

The standard pile frame illustrated by Fig. 1, is of all-steel construction and may be from 20 to 100 feet or more in height. The frame work serves to strengthen a pair of channels which form scope for adjusting the position of the frame if this becomes necessary during the progress of driving. Frames of moderate height and light construction are occasionally used without wheels or rollers, the channels normally used to carry the wheels being slightly upswept at the ends to act as skids.

The standard type of pile frame may be designed to take hammers up to 6 tons and piles up to 12 tons weight, and may be specially made for heavier loads. Frames of lighter construction are available in heights up to about 50 feet for driving lighter piles including steel sheet piles and timber piles. The weight of the hammer must be correspondingly less. This type of frame, illustrated in Fig. 2, has the advantages of light weight and simplicity of erection, the superstructure being hinged to the base and raised to the vertical by the winch.

Frames are also designed to rake both backwards and forwards (generally to a maximum inclination of 1 in 3) and to rotate through a full circle by rack and pinion. Such a frame is shown in Fig 3. A further very useful movement is a short in-and-out sliding motion for the superstructure (with its leaders) in relation to the base. A compensating adjustment to the raking screws at the back of the superstructure is necessary to bring the frame back to the vertical or to the required batter. This motion is particularly useful when driving steel sheet piling and when driving concrete piles which may tend to wander during driving from their intended position. All these motions may be power operated from the steam, petrol, Diesel-driven, or elecric winch nad in addition the frame may be travelled by direct drive to the rail wheels. Constructional details of such motions are illustrated by Fig. 4. Frames may incorporate some or all of these features,

*Paper read at joint meeting of the Institutions of Civil and Mechanical Engineers, March, 1944, and reproduced by permission.

†The British Steel Piling Company, Ltd., London.

Pile Drivers—continued

and hand operation of the raking and sliding motions is not uncommon.

Special pile frames can be constructed to position piles in any arrangement the designer of the structure may have chosen. Their use is generally confined to the construction of wharves and jetties where the basic need is for the frame to cantilever a distance at least equal to the span between successive lines or

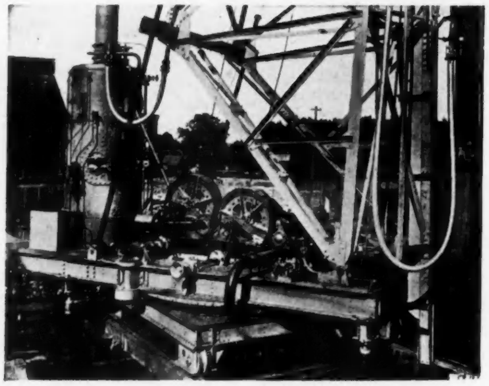


Fig. 4. Details of Power-operated Pile Frame

groups of piles. By this means the frame drives piles ahead of the supporting trach which in turn is generally supported on the piles already driven, although intermediate or temporary piles are sometimes necessary. In it simplest form a cantilever plant may consist of a pile frame mounted on a cantilever undercarriage built up of mild steel sections of width sufficient to allow the frame to be traversed across the transverse pile positions. Cantilever frames for driving vertical and raking piles in jetties to travel across the width of the superstructure. These so-called are generally provided with leaders free to swing, to swivel and "pendulum leaders" are suspended from the head of the frame and are pinned in the desired position. The superstructure may then no longer be in the form of the conventional pile frame but act as a tower to support the leaders, guide sheaves, anchorages, etc., for the ropes necessary to the operation of the whole machine. Fig. 5, shows a light cantilever frame of this description. Fig. 2 shows two fixed-rake frames (on separate travelling undercarriages) each arranged to swivel on curved rails for driving

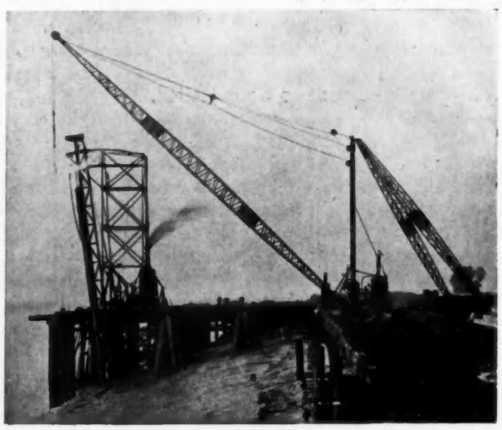


Fig. 5. Cantilever Pile Driver

clusters of raking piles. Figs. 2 and 5 show piles being pitched by independent derricks, a course frequently adopted when long and heavy piles have to be driven.

These cantilever and special frames are invariably power-operated by one or two winches and may in addition have hand winches to operate the traversing and raking motions of the leaders and the travelling motion of the plant as a whole.

Hammers

Drop hammers are of cast iron, generally rectangular in section, suitably proportioned and provided with a lifting eye and leader guide, both easily renewable.

Steam hammers are of two classes; fully automatic double-acting hammers, and semi-automatic single-acting hammers. In double-acting hammers the steam serves both to raise the ram or piston and to drive it down on to the pile. The valve gear is operated automatically by the steam and alternates the flow of live steam from the lower to the upper surface of the piston. In single-acting hammers the steam acts only to raise the ram to the top of its stroke from which it falls freely when the steam is exhausted. The hammer is only semi-automatic, inasmuch as the steam is admitted by manual operation of the valve lever. In most double-acting hammers the ram or piston moves to deliver the blow and is only a fraction of the total hammer weight.

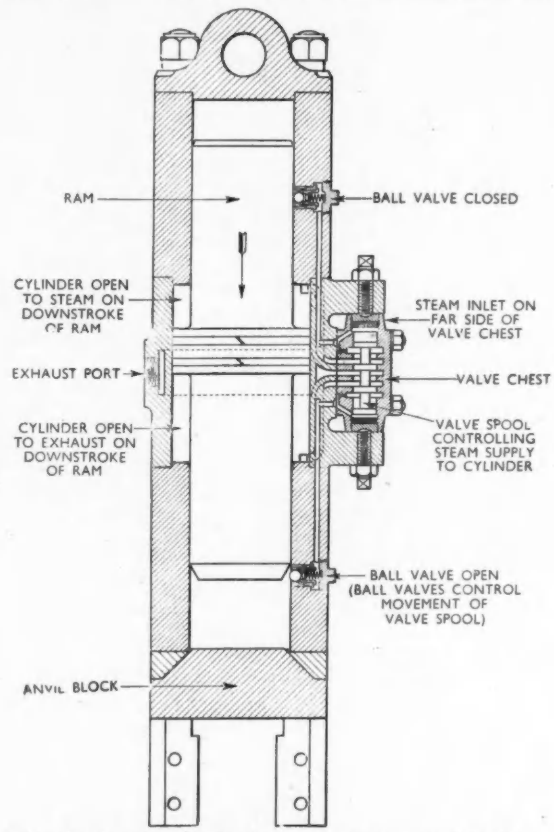


Fig. 6. Section through Double-acting Automatic Pile Hammer

In single-acting hammers the piston remains stationary and the cylinder, comprising the greater part of the total hammer weight, moves and acts as the ram.

All these hammers are designed to operate under a pressure of 90 lb. per sq. in. at the hammer. They can also be operated by compressed air; but as the quantity required is large, air is generally used only for the smaller sizes of hammer and when a compressor is more convenient than a boiler.

Fig. 6 shows a double-acting hammer of medium size in section. This type of hammer is made in about twelve sizes, ranging from about 1 cwt. to 6¼ tons total weight, delivering blows of 100 to 18,000 ft.-lb. with rams of from 21 lb. to 5,000 lb. and operating speeds from 500 to 90 blows per minute (the heavier hammers operating more slowly). Automatic hammers weighing as much as 16 tons have been built. The features of the type are rapid action and the simplicity of moving parts, which are totally enclosed. Furthermore, these double-acting hammers can be used without a pile frame and can thus be suspended from a

Pile Drivers—continued

crane, shear legs, or pole so long as they are steadied on the pile by means of attachments extending below the hammer and fitting closely to the pile. The heaviest hammers of this type may be used under water to depths up to 80 feet if compressed air at a sufficient pressure to exclude water is led to the bottom cylinder and the exhaust pipe carried below water-level.

A type of single-acting hammer is shown in section in Fig. 7 and is seen in operation in Figs. 2 and 5. These hammers are made with cylinders weighing from 1 ton up to 6 tons and more, those most commonly employed weighing from 2 tons to 4 tons

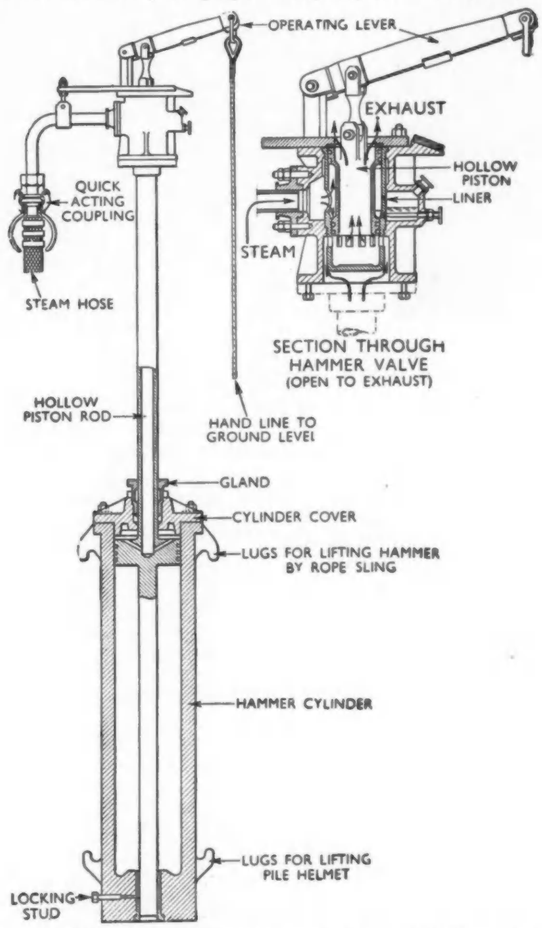


Fig. 7. Section through Single-acting Automatic Hammer.

with a maximum stroke of 4-ft. 6-in. The stroke is controlled by the amount of steam admitted to the cylinder and can thus be varied to suit the ground conditions during the driving of the pile. The speed of operation is also under direct control, the maximum being about 45 blows per minute. Various makes of this type of hammer are largely similar, the few points of difference arising according to the degree of success achieved in the reduction of condensation, expansive use of steam and automatic action, at the same time keeping valve gear and moving parts simple and robust enough to give trouble-free operation.

Internal combustion hammers have been produced within the last ten years. The first hammers of this type were designed to work on petrol or benzol with the usual electrical ignition automatically controlled and arranged to give some 60 blows per minute. More recently compression-ignition hammers to work on " gas-oil " have been successfully produced, the elimination of the battery giving this type of hammer obvious advantages. The Diesel pile hammer has so far been manufactured in sizes up to 1 ton, with a maximum stroke of 3 feet ; but part of the energy of the falling cylinder is used up in compressing the trapped air.

Double acting automatic hammers are widely used for driving steel sheet piling, to which their rapid action and ability to be slung from a crane particularly suit them. Timber staging piles and other piles carrying light loads can be driven by automatic hammers of medium power, but only the largest sizes are suitable for driving heavy reinforced concrete piles. Drop hammers and single-acting hammers are used for driving all types of piles. They are both commonly used for timber and concrete piles but infrequently for steel sheet piling. The choice of hammer type and size is dependent on many factors such as pile weight, penetration, load to be carried, and nature of ground. The ratio of pile weight to ram weight, which decides the efficiency of the blow, is important when driving bearing piles, and should not generally exceed 2 for concrete piles of moderate weight, up to 3 for very heavy piles. The heavier blow of the single-acting and drop hammers may be best for driving in clay ; but the rapid succession of blows from the automatic hammer may greatly reduce surface friction when driving in gravels and sands.

Winches

Power winches used with pile driving plants are of the friction clutch type. Different makers have various arrangements of clutch and clutch-operating gear, but the instantaneous control of clutch and brake common to all are essential for the operation of rdop hammers and the lifting and pitching of piles. Double drum winches are commonly used, one drum operating the hammer and the other used for pilepitching. Single-drum winches may be used on light pile drivers, and treble-drum winches on large machines where two lines may be usefully employed to control the pile. Drum shafts are usually extended to carry warp drums of which use is made to travel the pile frame, drag running timbers into position, etc.

Pile-driving winches are seldom designed for drop hammers heavier than 4 tons. Lifting speeds may vary from 70-80 ft. per min. up to 200-250 ft. per min. High lifting speeds are of little advantage except in drop hammer work, as piles, particularly reinforced concrete piles, have to be handled and pitched with care and the time taken in lifting automatic hammers is only a very small part of the total time taken to lift, pitch, and drive a pile. Some makers design piling winches to operate a drop hammer off one drum at high speed, and to lift off the other a load two or three times greater at a correspondingly slower speed. Other makers design both drums for equal loads and speeds and provide return blocks in the rope arrangement when heavy concrete piles have to be lifted.

Steam-driven winches remain the most popular, particularly as steam is invariably required for the hammer ; but for drop hammer work, petrol, Diesel-driven, and electric winches are now frequently used and are entirely satisfactory so long as engines or motors are of ample power and the chain drives are designed to take a sudden application of load.

Boilers and Compressors

Boilers mounted on pile frame bases have to be portable and those commonly employed are the vertical cross-tube and vertical water-tube types. The essential requirements are : ability to raise steam quickly and economically ; minimum floor space ; and no tall chimney. Boiler mountings have to be dismantled frequently for transport, and should not therefore be fitted direct to the boiler shell but to mild steel pads studded to the shell. Two injectors, or one injector and one feed pump, should be provided, the latter combination being preferable. Safety valves should be spring-loaded as the boilers are often subject to vibration.

Most boilers used in this country are coal-fired. Oil-fired boilers give a greater evaporation for a given size of boiler and maintain a more uniform output with less attention. They are however, heavier and much less portable owing to the firebrick lining, and take longer to start up. If wood fuel is used, the boiler size should be increased to allow for the low calorific value of the fuel.

Air compressors need have no special fittings but should have a large air receiver for the hammer to draw upon when working at maximum stroke and speed.

Pile Drivers—continued

Special Types of Pile Drivers

Floating pile driving plants employed occasionally in docks and navigable rivers commonly comprise a standard pile frame with winch and boiler mounted on a substantial pontoon or pair of barges, the plant being dismantled on the completion of work. For special works, floating plans are constructed with steel pontoons fitted out with the usual accessories of floating craft and given storage accommodation for fuel and water. Many special plants of this type with a draught of 3 and 4 feet have been constructed for the large irrigation projects in India, Egypt, and Iraq. Their function is to drive steel sheet piling for large cofferdams, and they carry two pile frames with special travelling leaders so that a run of 15 or 20 feet of sheet piling can be driven without alteration to the position of the pontoon. Derrick cranes are mounted alongside the frames to handle and pitch the sheet piles ahead of driving. Other floating plants may have only pile frame, winch, and boiler ; but the craft shown in Fig. 8 constructed for harbour maintenance, carries a raking pile frame and a grabbing crane also designed for lifting buoys, anchors, etc.

Other special plants include railway pile drivers for which leading dimensions are limited by the loading gauge. These machines are generally in the form of a crane with hanging or swinging leaders supported by some form of adjustable boom, the crane jib being lowered out and the boom removed when travelling.

Derricks, locomotive cranes, and excavators are also adapted for pile driving by suspending a set of leaders from the jib, but are generally used only when the number of piles to be driven is small. Certain specialist contractors for patent foundation piling systems have their own form of mobile piling plant.

Pile Extractors

Some makes of double-acting steam hammers previously mentioned can be used inverted, fitted with a special extracting attachment and suspended from a crane jib or pile frame. The upward hammer blow acts on a crosshead and is transmitted

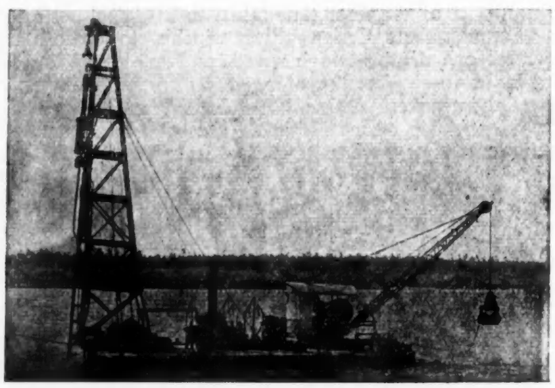


Fig. 8. Pontoon Pile-driving Plant

through heavy steel links to jaws gripping the pile and the pile hammered out of the ground. The usual form of jaw incorporates wedge-shaped serrated dies which grip the pile all the more firmly as the pull on the suspension rope increases. Other machines, also automatic and driven by steam or air, function only as extractors, one type being illustrated in Fig. 9.

Single-acting semi-automatic hammers can be adapted for pile extraction and are capable of giving a powerful upward blow. The gear required is not of general application, but one patent foundation piling system is dependent on the use of single-acting hammer in this way.

Very strong pulls can be applied to piles through hydraulic jacks so long as the reactions can be taken up. A standard grip is suspended from a heavy girder which spans between the jacks and pull up to 200 tons can thus be applied.

Conclusion

Pile-driving plant is subjected to very rough treatment, and manufacturers naturally produce robust plant, not always giving sufficient consideration to the weights which the user has to handle. The development of high-tensile and special alloy steels and lightweight metals may in the future lessen the heavy nature of piling operations. The designer of piled structures can also contribute to this end by giving due thought to the plant which has to be used for pile driving, and there should be more collaboration between civil engineering designers and the specialist firms of piling contractors and plant manufacturers so that no unnecessary awkward structures are proposed.

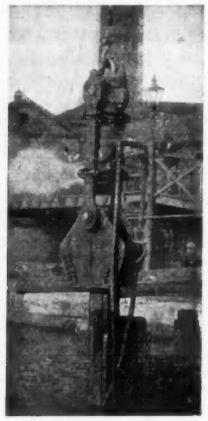


Fig. 9. Pile Extractor

Steam-driven plant has long remained in favour and is unlikely to be displaced in the immediate future by Diesel hammers or electrically-driven machines, except for relatively light operations. Steam at higher pressures may be useful if suitable hose and pipe connections can be provided, and there is great scope for improving the overall efficiency of pile drivers in their present form and thus economising in fuel.

Much has still to be learned about the behaviour of piles during driving and the stresses imposed in them. Fundamental considerations of impact show that a heavy ram with a short drop is preferable to a light ram with a long drop. The weight of ram, and energy of blow, must, however, be more closely linked with the weight and design of the piles themselves ; and driving stresses. particularly in the case of reinforced concrete piles, must be kept within safe limits. All these considerations will influence the design of pile drivers until eventually plant will be produced to drive piles with known forces, without exceeding known stresses, so that loads may be carried with certainty but without the waste and extravagence often concealed in the factor of safety.

Port of Arromanches Pontoons

It has been disclosed that the pierhead and jetty pontoons manufactured for the invasion port of Arromanches, in Normandy, were designed with spud anchorages on the same principle as those used with dipper dredges, most commonly in vogue on the coast of North America. Messrs. Lobnitz and Co., of Renfrew, having had considerable experience in the building of this type of dredger, were commissioned by the War Office to design a spud anchorage suitable to the conditions prevailing on the Normandy beach. The spuds, which are long steel joists, pass vertically down through grooves in guide frames on the pontoon at each of its four corners. Each pontoon has a diesel-electric power plant and four electrically-operated winches. The spuds, with their feet resting on the sea bed, are lifted and lowered by rotating the winch drums. In calm weather the pontoon floats freely up and down as the tide rises and falls, the deadweight of the spuds affording sufficient anchorage. Generally, however, it has been necessary to lift the pontoon slightly out of flotatem to give the requisite pressure for stability and secure anchorage.

Over eight miles of caissons, weighing 1,014,000 tons were required to make the artificial port at Arromanches for the invasion of Normandy. Of this, five miles, weighing 668,000 tons, two-thirds of the whole, were constructed in the Port of London.

The Port of London was responsible for 75 per cent. of the total concrete work. The caissons were built in dry docks, wet docks and temporary riverside basins. Thames Watermen played their part in the " launching " of the caissons from the riverside basins. At the peak of construction some 14,000 men were employed on the work in the Port of London.

Stresses in Dry Docks†

By DONALD HAMISH LITTLE, B.Sc. (Eng.), Assoc.M.Inst.C.E.,
and
ELVET JOSEPH EVANS. B.Sc., A.M.I.Struct.E.

Introduction

IN designing docks, a knowledge of local geological surface deposits is essential for accurate work. Borings as a means of ascertaining soil characteristics seldom reveal sufficient data, partly owing to the small number of borings taken, and partly because, for different reasons, the borings cannot be taken sufficiently deep. At best, the data are inconclusive.

Generally, then, the designer is faced, at the outset, with the fact that he has no precise knowledge of local ground conditions upon which to work. In any case only in theory do homogeneous, elastic earth masses exist wherein the stress-propagation in all directions obeys the same laws. In these circumstances it appears advisable to make certain assumptions and to try to determine two limiting values of a given stress such that the true value lies somewhere between them.

This will be illustrated later by a worked example for a given dock, but as the method is largely one of trial and error, consideration will first be given to the various possible theoretical lines of approach to the problem.

Theoretical Approach to the Problem

The designer's first task is, by rough preliminary calculation, experience, and practical requirements, to determine the profile of wall and floor. He has then to investigate the stability of the section thus found in order to be satisfied (*a*) that the dock itself will not be overstressed internally, and (*b*) that ground pressures will not be excessive.

To evalute these stresses exactly, it is necessary to know :—

(*a*) the dead weight of the dock itself ;
(*b*) the superimposed loads due to water when flooded and to ships when docked ;
(*c*) the earth pressure on the back of the wall ;
(*d*) the hydrostatic uplift, if any, under wall and floor ;
(*e*) the modulus of elasticity of the dock structure ;
(*f*) the modulus of elasticity of the ground in which the dock is founded.

Assuming the dock to be built in mass concrete, the dead weight can be accurately assessed ; so, too, can the weight of the water when the dock is flooded. The weight of the ship per linear foot cannot be given with real exactitude, but for design purposes a definite maximum value can be adopted.

The determination of F, the resultant thrust acting on the back of the dock wall due to earth pressure, depends mainly on the properties and moisture-content of the backfill. In the light of recent soil mechanics knowledge, there seems to be more agreement about the magnitude of F than about its point of application. However, for dock work, it can safely be assumed that the earth will be waterlogged and that pressures will be of a hydrostatic character. Consequently, for the determination of F, the Rankine formula can be represented in the form $F = wh^2/2$, where h denotes the height of the wall and w the weight of an "equivalent" fluid, which, for calculation purposes, is assumed to replace the retained earth. It is obvious that the method of equivalent fluid presupposes that the backfill is horizontal, that friction between wall and backfill is neglected, and that F is horizontal. The position of F is taken as $h/3$ from the foot of the wall.

Generally it is safe to assume that full hydrostatic uplift will act under the floor and walls—the level being to high water for docks opening direct into tidal waters or basin level for docks opening into closed non-tidal basins. In support of this assumption Terzaghi has indicated that any surface of a solid substance in intimate contact with submerged clay is subject to the action of full hydrostatic uplift as if the adjoining porous material were not present. Many instances have occurred of dock floors lifting, even to the point of failure, which further supports the assumption. The only condition under which hydrostatic uplift would not become operative is when the dock is constructed on rock, and in that case the floor would be vented as a precautionary measure.

The modulus of elasticity for mass concrete increases with the richness of mix, repetition of stress, and similar factors. The actual values, even for one mix, lie between wide limits. The elastic property of the foundation material is termed the foundation modulus, K, which is the load required per square foot to compress the ground 1 foot. Over a wide area, such as a dock base, it is clear that large variations in the value of K are to be expected.

Assuming that all six quantities (*a*) . . . (*f*) could be accurately assessed, then, considering the section of the graving dock as a beam with variable moment of inertia resting on an elastic foundation equations based on slope deflexion methods can be evolved and a mathematically correct computation of stresses in the ground and the dock structure can be obtained. Such a process would be rather difficult and lengthy. These reasons alone are no justification for not adopting such an analyis ; but when the uncertainty of some of the fundamental considerations is taken into account, it is considered that the method is unreasonable and impractical.

Before presenting the alternative approach to the problem it is as well to discuss, in general terms, the behaviour of earth masses under stress.

Behaviour of Earth Masses under Stress

Small-scale experiments have been carried out, and field observations taken for recording the distribution of pressures under foundations. The resulting pressure diagrams are helpful for comparison purposes. Professor Krynine, in his "Soil Mechanics," states that "pressure distribution under uniformly loaded wide structures is probably more or less uniform, with disturbances at the edges. Examples of such structures are dry docks or large water and oil tanks resting on the earth's surface."

It must, however, be constantly borne in mind that the experiments were carried out with selected soils, as near to the idealized earth masses as possible. Professor Krynine points out that for the purpose of investigating stresses and strain in actual earth masses, the latter is to be visualized as either :

(*a*) a homogeneous elastically isotropic body obeying Hooke's law ;

or

(*b*) an idealized fragmental mass possessing friction and sometimes cohesion.

The essential difference between these two kinds of idealized masses is that (*a*) is made of one material throughout, and if loaded within certain limits, it recovers completely its original shape when the external forces are removed ; it has no pores ; (*b*) is fragmental, porous, and close to the surface, and does not obey Hooke's law. At great depths, however, an idealized fragmental mass is regarded as isotropic.

It is obvious that most earth masses, being porous and not obeying Hooke's law, fall rather into category (*b*), than (*a*). For practical consideration an example of (*a*) is clay and of (*b*) sand.

Enger, Kögler and Scheidig, and many others have carried out experiments with fragmental material such as sand. All results agree that for a rigid load system higher pressures are recorded under the middle of the loading plate than near its edge. These experiments reveal that the pressure under the centre of a loaded plate may be as high as 200 per cent. to 300 per cent. of the average value p, where $p = W/A$, W denoting the total weight

†Reproduced by permission from the Journal of the Institution of Civil Engineers, December, 1944.

Stresses in Dry Docks—continued

of the loaded system and A the area of the base. These high values are accounted for by the escape of particles of the fragmental mass from under the edges of the loaded plate. Repetition of the experiments, using larger base-plates, revealed a marked decrease in the maximum pressures.

Of more interest to the dock designer is the experiment of Dr. Oscar Faber, M.Inst.C.E., in which, to prevent the escape of sand particles at the edge of a circular loaded plate, he used a concentric circular surcharge around the plate. The pressure under the centre of the load was approximately 150 per cent. of the average pressure p. The theoretical value for an idealized fragmental mass would be 100 per cent. of p.

Relatively few similar experiments have been carried out with clay. Dr. Faber, however, repeated the experiment referred to above, using clay in place of sand, and found that pressures are highest under the edges of the loading plate, and lowest under the centre.

Summarizing, these researches indicate that under a rigid loaded plate :—

(*a*) a clay mass is overloaded at the edges ;
(*b*) a fragmental mass is overloaded in the middle.

The foregoing remarks apply to *small scale* laboratory experiments only. For practical purposes, that is, for the consideration of actual engineering structures, the size of the loaded area has a marked effect upon the distribution of pressure under that area.

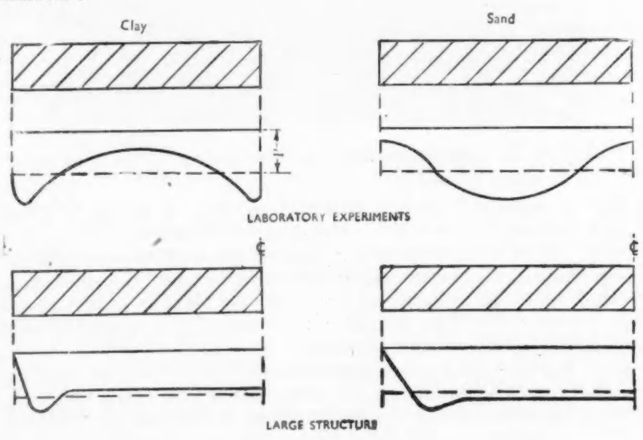
It is clear that the pressure-distribution at the base of a uniformly loaded infinitely wide structure is uniform. If it be imagined that the base assumes finite, but large, dimensions, it is reasonable to conclude that the pressure under the centre region of the base is unaffected, any variation in pressure-distribution being under the edges of the base.

This line of reasoning led to Professor Krynine's statement regarding pressure-distribution under wide uniformly loaded structures, referred to above.

There appears to be no mathematical theory by which an assessment of pressures under the edges of a large base can be arrived at. However, foundation pressure recordings during the erection of new structures have definitely confirmed overloading near the edges of the base. Cells under one concrete base (51 feet long by 38 feet wide) recorded maximum edge pressures of $2p$, where p, as before, denotes the average pressure.

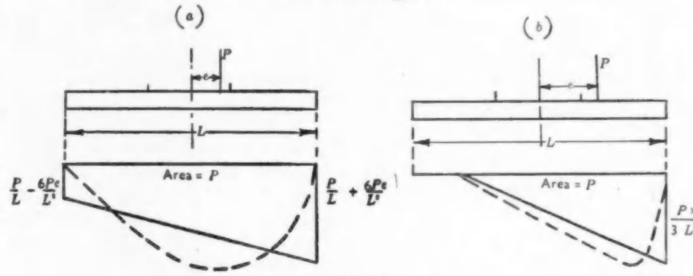
Another factor which affects considerably the distribution of pressure is the rigidity of the structure. Some designers assert that if the base is sufficiently rigid all structures may, for the purpose of investigation into foundation pressure-distribution, be regarded as uniformly loaded.

A diagrammatic summary of the foregoing would be as follows :—



Figs. 1

If a structure is assumed to be rigid it can sink bodily or rotate from the action of the forces acting on it, but no movements it may experience can distort the base ; that is, if in section the base is a straight line it will remain straight. If the foundation is perfectly elastic it follows, since the reaction at any point is proportional to the displacement, that the vertical reaction stresses upon the base of the structure follow a linear law. If the structure is not rigid, or the foundation is not perfectly elastic, the distribution will be modified ; but since it is impossible to state the elastic condition of the foundation, an exact distribution cannot be determined. In these circumstances it is customary always to assume a linear variation of normal stress across the base, the limiting values of which are read off as indicated in Figs. 2.



Figs. 2
(a) P falls within middle third (b) P falls outside middle third

L denotes the width of the structure base and only a strip, one unit long, of the base is considered.

In the light of the preceding remarks on the behaviour of loaded earth masses, the stress diagram as indicated by the broken line may be taken as presenting a more likely distribution, the area under the broken curve being equal to P, the total load. The important point, however, is that whilst the pressure-distribution is different, the maximum stress is, for the problem under consideration, approximately the same for both diagrams.

Alternative Approach to the Problem

To proceed with an alternative approach to the problem, various assumptions for certain forces are made and the consequent values for the remaining forces are calculated. By repeating this over chosen values a range of forces can be arrived at and a limit placed to their upper and lower effects. Within this limit experienced judgment has to be exercised to come to a final decision.

Three main loading conditions have to be considered, namely :—

(1) dock empty—no ship load ;
(2) dock empty and a vessel docked ;
(3) dock flooded.

With each of these conditions, for the purpose of design, full or no hydrostatic uplift may be assumed under the walls and floor. There may, moreover, be local areas of hard unyielding ground (possibly rock) under the structure, and the designer has to satisfy himself that the structure is stable for the most critical position of these unyielding areas ; for example, under the toe of the wall only, or under the centre-line of the floor only. There are then, upwards of ten different possibilities which may have to be considered.

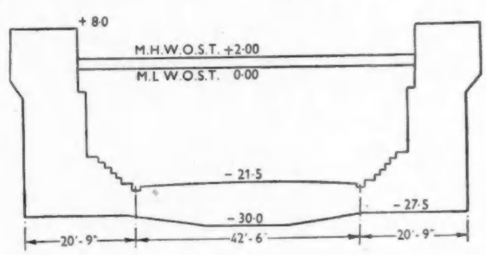


Fig. 3
Typical Cross Section Through Dock

As an example of the alternative approach, the design for a hypothetical dock will be dealt with in detail. A typical cross-section through the dock is given in Fig. 3. The actual dock would have a subway and additional altars, but for design purposes the simplified profile as shown is sufficient.

(*To be continued*)

Coast Defence against Marine Action*

Problems and Precautions

By PABLO SUAREZ†

(Concluded from page 240)

III FORM AND STRUCTURE OF DEFENCE WORKS

A. Longitudinal Adherent Works

The longitudinal adherent works employed for the defence of coasts ought to be in conformity with a certain number of conditions.

In revetment works which have the object of deadening the force of the waves by causing them to ascend a slope, the section ought to be such as to form an absorbent for the greatest amount possible of the kinetic energy of the direct wave and to be a directive of the return wave by as smooth a transition as possible down the slope of the beach. From this point of view an S-shape section may be convenient. A parabolic profile completed by a horizontal component from the crown of the work is more advantageous than a circular arc and also preferable to a cycloidal curve. The horizontal component, to which allusion has already been made, ought to be formed by a platform of variable width and slightly inclined towards the sea, being bounded in its outer part by a walling which engages through a gentle curve with the body of the work, arranging that the tangent to this curve at the point of inter section with the profile and the ground behind shall approach vertically. This shape is adopted in order to reduce the amount of spray which can pass over the crown of the work.

The parabolic arc may present a certain inconvenience in application. Having regard to the height of the slope to be protected, which may be rather importnat, 3 metres for example, it may be necessary on account of deepening the foundations to extend it further. The development of the parabola becomes excessive and the benefit of the lesser thickness of the work is lost. On that account the theoretic parabolic arc is generally replaced in the lower part by a straight slope. In shingly beaches, this straight slope can be commenced at the point where the to the parabala is already slightly inclined to the horizontal (a slope of $\frac{1}{\sqrt{3}}$ per metre). On the other hand, on sandy beaches, where the effect of surf is more apparent by reason of the greater mobility of the material, it is essential in defence works to provide flatter slopes and these may vary between 1 and 5 to 1, being in every case a function of the violence of the sea and of the greater or less facility with which the sand is displaced.

The works ought to be founded at sufficient depth and in such a form as to preclude undermining and so that partial damage of this kind can be readily made good. Abrupt change of section at the foot of the wall should be avoided whether in the shape of the wall itself or in the construction of a berm of slope approximating as closely as possible to that of the natural beach. This berm is designed to take, if necessary, the impact produced by the retiring wave and to withstand the suction which at times is indeed, sucking into the sea fluid and moveable sand from underneath the work. To prevent undermining, mattress work and timber piling and the face of the work can be protected by rubble, either in natural pieces or with blocks of concrete.

Revetments ought to be impermeable both as regards sea water and fresh water infiltrations.

Also for this class of work as for all others for coastal defence against marine attack, those materials should be utilised which are more easily obtainable in the neighbourhood, so as to reduce as much as possible not only the cost of construction but also the cost of upkeep and maintenance. Nevertheless, the use of fascines and bundles of brushwood should be avoided as much as possible as there is no character of permanence in works so executed.

Revetments can be made of masonry with cement or hydraulic lime mortar and on shingly beaches there has been tried a section composed of a simple revetment of masonry resting on a bed of clay or gravel over the littoral belt suitably levelled. Revetments of masonry should be provided with expansion joints at regular distances apart (10 metres, for instance).

For some time past, reinforced concrete has been employed on the construction of works of this nature in accordance with what appears to be an appropriate application, even if somewhat costly. Revetments of reinforced concrete possess greater cohesion and solidity than revetments of masonry and they offer better resistance to flexure, which may be caused by vacuities behind the revetment. Reinforced concrete piles admit of powerful penetration into the ground. The forces of contraction and expansion produced in a coating of reinforced concrete by variations of temperature and by moisture can cause dangerous cracks detrimental to the preservation of the reinforcement. There has been adopted a form of revetment consisting of a rigid reticulated framework made with T-shaped beams, arranged horizontally and following the line of maximum slope with thin reinforced slabs as a veneer set between them. This type of construction, designated Muralt, has had numerous applications in the Low Countries.

There has been a period in which much discussion has taken place on flexible revetments by forming in one way or another a network covering over the slope of the work to be protected. All these have been constituted by slabs of different materials connected by metal ties—copper, aluminium, galvanised steel, etc.; none of them has given the results expected, seeing that even if they are considered water tight, when hollows occur behind them, the component parts are disorganised and the joints opening on the outer face, lose their impermeability and give passage to infiltrations of water and fine sand, more or less harmful in effect. On the other hand, the foot of work so constructed is bedded under conditions such as require, as in the case of rigid revetments, the formation of a berm.

B. Longitudinal Works against Impact

Longitudinal works designed to resist the direct impact of waves, can take the form of walls, or even the character of true breakwaters in the sea, or again, may be fashioned as wave-breakers. In all cases the foot of the work must be harmonised with the beach so as to avoid any action by backwash.

Works bearing against the natural ground present the aspect of true-retaining or protective walls analogous to those which face rocky coasts and can be formed by a mass of dry masonry protected by a parapet of masonry of cement or hydraulic lime mortar. This can, in turn, be composed of large artificial blocks of cyclopean concrete resting on a bed of the same material carried on a row of timber piles. In some cases there has been provided also a row of piles behind the dry masonry, and between that and the background as far as high water level has been placed a bed of clay up to 1.50m. in thickness.

The height of the crown of these walls depends likewise on the level of high water, on the outline of the outer portion of the protective work and on the way in which the wall terminates in its upper part.

If the parapet is vertical, waves mount many metres above sea level. It is economically impossible to construct walls sufficiently lofty to repel the spray. The crest of the waves does not return with a vertical fall on the seaward side because the storm flings

* Translation of Spanish article in *Revista de Obras Publicas*, November, 1944
† Ingeniero de Caminos

Coast Defence against Marine Action—continued

them inland over the coping of the work. If the protective work is enclosed and overhangs at the top, the wave on the contrary, is deflected smoothly to the slope and the action of gravity annuls its kinetic energy. Spray of any great magnitude cannot be produced as in the case of vertical walls. The most that can happen is that the contact between the descending waves may produce splashes which, in any case, are of little importance.

Finally, both types of wall require the upper ground surface to be protected by a horizontal berm. The width of this protective berm is of as much or more importance than the height of the wall. These two dimensions are tied between themselves and the exterior profile of the wall. The berm can be the narrower the greater the height of the wall and reciprocally. A great height of wall enhances the cost of the work to a much greater degree than a great width of berm which can be constructed in a light form; from which it is clearly evident that it is more advantageous to construct wide berms than lofty walls. On the other hand, the berm ought to be wider and more substantial for vertical walls than for inclined walls. In fact, the waves which the wind drives inshore fall in the first instance with considerable force on the berm and the wave which encounters smoothly and without shock an inclined parapet is deadened in a smaller space.

In regard to breakwaters in the sea, these are installed on the same beach to be protected and their profile ought to be such as to avoid the total impact of the wave on a single point, especially at the base of the work. Accordingly, a stepped profile is the most suitable, the body of the work being constituted by a core of rubbble covered with hydraulic line masonry in which are embedded large salient pieces, so as to form a rugged surface. A like recommendation is applicable in the case of wave breakers constructed on the same system, with in all cases an exterior slope as gentle as possible.

Wave breakers ought to be calculated and constructed as such, founded directly on the sandy floor or well bedded in the subsoil by means of gratings secured to the bed of clay which lies below the sand. To give greater security and when there may be fears of undermining, timber sheet-piling can be utilized and the foot of the work protected by large blocks.

C. Transverse Works or Groynes

When the defence works are formed of transverse groynes, as has already been stated, these ought to be located in plan at right angles to the shore line, and customarily they are in single alignment. However, in recent times, attempts have been made to arrange groynes in two alignments like a T or a cross, in which case the defences ought to include, in addition to the groynes, a longitudinal protection work, with the object of being supported by the second groyne alignment which acts as a true wave breaker. This class of groynes has not, however, received the sanction of experience.

The selection of the transverse section of the groynes ought to be made on the principle of not cutting abruptly the currents or the waves but to deaden them gradually without causing rupture. The best profile is that of slight curvature or of inclined planes, provided at the foot with suitable protection from undermining.

The groynes ought to be solidly bedded into their abutments, whether the coastline or the longitudinal work which protects it.

Groynes can be constructed of timber, consisting of logs fixed into the ground with a lining of planks, connected and strengthened by bracings and clamps. This type of groyne has numerous drawbacks; among them is easy attack by *teredo* which destroys the logs rapidly while, in addition, their vertical face gives rise to an accumulation of sand on one side resulting in its acting as a retaining wall, but favouring undermining against the vertical face and so contributing to its destruction.

A similar form can be achieved in reinforced concrete, thus avoiding destruction by marine organisms and augmenting the resistance of the work, though the danger of undermining still persists.

Also fascines have been used, consisting of bundles of thick brushwood and wattles, but these ought to be avoided as much as possible, because the materials only remain in sound condition while completely submerged.

One form of mixed groyne is that formed by two rows of timber piling between which is placed rock rubble resting on a bed of fascines. The upper part is formed of concrete blocks and the sides are raised at a slope of 1 to 10. This inclination considerably increases the stability. The sides are supported by logs fixed in the ground for 2/3rds of their length. The diameter of these logs should increase from some 22cm. in the lower part to 27cm. in the upper part.

As this type exhibits the inconvenience of a possible disintegration by wave action and decay of the timber, the defect has been remedied by completely suppressing the timber, including the logs and the fascines. Instead, groynes have been constructed of boxed caissons, formed with metal sides with cross bulkheads, 10 metres apart, of the same material, filled with sand and covered with a layer of weak concrete and a fabric of masonry, like a pavement of hard rock. In order to protect the head of the groynes and their flanks from undermining, they are surrounded by rock rubble forming a gentle slope of weight sufficient to resist displacement by wave action.

Groynes may also take the form of a true transverse breakwater, composed of a mound of quarry refuse covered by a protective coating. The outer face, which has to resist the shock of storm waves, ought to have a slight slope and be stoutly protected by natural stone or blocks, which cannot be disturbed by the heaviest seas. The other side may be steeper and formed of lighter blocks. If the groyne is liable to storm wave attack on each side alternately, the two sides should have equal slopes. There are some who hold it as a general rule that groynes consisting of a mound of sand, covered with a masonry revetment cannot be employed elsewhere than on beaches with a regimen of little variation.

Lastly, as a curiosity, may be mentioned the submarine groynes installed at Bray, near Dublin, on a system consisting of heavy iron chains anchored in deep water or moored to blocks of concrete, to which are attached large branches, hurdles and other material suitable to bring about the deposit of the alluvium in suspension in the water; it would appear that the results obtained have been satisfactory.

First Aid Treatment at London Docks

The Port of London Authority have circulated the following information respecting their First Aid Service.

Despite the stringent rules governing work in the docks at all times, the hazards and dangers in dockland are much increased in hard wintry conditions. But at all times the motor ambulance service of the P.L.A. Police Force is alert to provide first aid treatment throughout the docks. The equipment carried in the ambulances includes the most modern appliances, including a special type of stretcher constructed with metal shackles, bolts and steel wires to enable the stretcher to be lowered into the holds of ships. Another type, the Rocking Resuscitating stretcher, is used for cases of suspected drowning; this equipment is invaluable in circumstances where the patient is suffering from chest injuries and the Schafer method of resuscitation cannot be applied. With the latter equipment is a carbon di-oxide gun which is used in conjunction with the movement of the apparatus to encourage breathing. Flannel suits are carried in the ambulances for persons rescued from the dock waters; wet clothing is removed, stimulants given and the Ambulance Attendant dresses the patient in a suit for warmth and precaution against shock.

Another interesting apparatus is the "Barnes" equipment which enables injured patients to be removed from confined spaces, such as ship's engine room, tunnel shafts, etc., without the risk of causing further injury. Ammonia masks also form part of the ambulance equipment; these are used to restore workers in cold air stores who may be overcome by ammonia fumes. Injured dockers and seamen gratefully acknowledge the fine services rendered.

The P.L.A. Ambulance drivers and attendants are chosen for their knowledge and interest in first aid duties. Actually all officers in the Authority's Police Force hold the St. John's Ambulance Association's Certificate for first aid.

Bonavista Harbour, Newfoundland

Formation of Two Breakwaters

As announced in our February issue, two breakwaters have recently been constructed at the Port of Bonavista on the Western Coast of Newfoundland. For the following particulars, as also for the illustrations, we are indebted to the Canadian Journal, *The Shipping Register*, of Montreal:

The Harbour of Bonavista, showing the two Breakwaters

Bonavista, a fishing town of 5,000 inhabitants on the north-east coast of Newfoundland and close by what was to have been the landfall of John Cabot who crossed the Atlantic in the Matthew in 1497, has been provided with a harbour by the Government.

The project was carried out by the MacNamara Construction Company of Leaside, Toronto, Ont., at a cost of about $300,000. Some conception of the engineering difficulties which had to be overcome may be formed from the fact that the rugged coast faces the ocean, taking the brunt of seas of the north-east gales and the grinding force of the ice floes brought south by the Arctic current.

The harbour is formed by two breastworks, one projecting from a point on the shore called Canaille for a distance of 1,000-ft., the other, from Mockbeggar, for 700-ft. The breakwaters are built of rock with concrete cribs on the outer ends. In the more exposed parts rock weighing 30 tons were used. The concrete cribs reinforced with ⅝ths and 1¼-in. steel rods weigh 3,000 tons, were filled with solid concrete. Floated in position, they were sunk at the ends of the breakwater. Some 110,000 cub. yds. of rock were used in the construction.

The Port of Bonavista, Newfoundland

The breakwaters stand 12-ft. above high water mark and vary in breadth from 32 to 42-ft. on the top with the base measuring 100-ft. or more. They are built with a slope seaward of a ratio of 1 to 1½. Over the Mockbeggar breakwater extends a road, protected on the seaward side by a parapet 6-ft. high. The entrance is 210-ft. wide with a depth of 15-ft. at low tide. The basin covers 21 acres.

This facility should prove of immense importance to the fishing industry prosecuted from the shore. Formerly the motor and other boats used had to be hauled out of reach of the seas in stormy weather. Now they are enabled to ride at anchor in the basin. Owing to the lack of a harbour the fishery had to be discontinued in the early autumn because of the uncertainty of the weather, although the fishing grounds abounded with cod. It will also make possible the use of larger craft capable of making longer voyages and of riding out storms. The establishment at Bonavista of a fresh fish processing plant makes it far more necessary that the supply should be continuous than was the case previously when the industry was restricted to salt fish curing.

Legal Notes

Cargo-handling Mishap: Absence of Preventer Line

At the Liverpool Assizes on February 1st, a dock labourer, Mr. Thomas James Roberts, sued Messrs. Alfred Holt and Co., shipowners, for personal injuries alleged to have been due to a blow from a sling carrying steel pipes which were being loaded from the quayside into the steamer *Carlton* at Vittoria Dock, Birkenhead. The following report of the case is extracted from *Lloyd's List*.

Roberts gave evidence that his duty as railman was to see that the sling was properly lifted over the ship's side, and to give the signal for it to be lowered into the hold. He was hit on the head by the sling and sustained injuries.

It was submitted on behalf of Roberts that the guy rope gave way, and that the accident would have been avoided if the preventer wire had been fixed to steady the sling in its progress to the hold, or, if the derrick had been lifted, to give a greater clearance over the deck.

For the defence negligence was denied, and it was contended that the accident was due to the action of one of the winchmen and that a preventer wire would not have prevented the accident.

Captain Bell, stevedore superintendent for Messrs. Holt, stated in evidence that it was not a practice in the port of Liverpool to use preventer wires.

Other witnesses gave similar evidence.

Judgment

Finding for the defendant company, with costs, **Mr. Justice Singleton** said that the contention had been made for plaintiff that it was a recognised practice to use a preventer wire in loading ships in the port of Liverpool. This, however, had been strongly challenged by witnesses representing stevedoring firms, who said it was unnecessary to have preventer wires when weights of less than a ton were being lifted. Captain Bell, who had had 19 years' experience, had stated that the standard rigging of a ship was always considered sufficient in Liverpool, and said he would never dream of using a preventer wire for sling loads of this description where the weight was under half a ton. He said he would not consider its use for anything less than 25 cwt.; while another witness had said that two tons was in his opinion the weight that might necessitate a preventer wire. That view was supported by another witness.

"With evidence of that kind from men of great experience," continued his Lordship, "it is quite impossible for me to say that Messrs. Alfred Holt and Co. have failed in the performance of their duty and have been negligent. They have followed the usual custom of the port of Liverpool, and had anything been found to be defective it would have been changed."

The Judge added that the defendant company did not use a preventer wire in this instance because they considered it was not necessary, and, further, that if they did use it and there was a pull between the two winches, such as must have taken place in this instance, something must have given way as a result of this tug-of-war, and there would have been an accident.

Business Announcement.

Taylor, Woodrow Construction, Limited, announce that they have moved their London Offices to 10, Park Street, W.1 (just behind Grosvenor House). They are in occupation of the complete building at this new address, and the increased space available has been needed for some time, to deal with the continued development of their business.

Review

The Port of New Orleans, published by the Board of Commissioners, Port of New Orleans, State of Louisiana, U.S.A., December, 1944. Pp. 34, with numerous illustrations.

A Foreword to this attractive publication explains that it is designed "for the purpose of giving the citizens of Louisiana more knowledge of, and thus greater pride in their own great Port of New Orleans." The object is admirably achieved by a full account of the constitution, functions and membership of what "by common consent, but without legal sanction, has for many years been generally referred to as the 'Dock Board,'" a term which for English readers, needs elucidation, since it refers entirely to riverside wharves. There are no docks (impounded water areas) in the English sense of the word, at the Port of New Orleans, unless the Industrial Canal, with its single lock, is considered as an elongated dock. There are shipping berths along the canal banks, but the main object of the canal is connection between the Mississippi River and Lake Pontchartrain, an arm of the Gulf of Mexico. The river level is generally higher than the lake level—hence the necessity for a lock—and there is a minimum depth of water over the lock sill of 31½-ft. below Mean Gulf Level.

The opening chapter by Mr. Eldon S. Lazarus, general counsel to the Board of Commissioners, defines the legal status of the Board. It is followed by an article on the "Background, Policies and Future" of the Port from the pen of Mr. Pendleton E. Lehde, the president of the Board. There are further chapters on the Proposed New Outlet to the Sea and on the Industrial Canal. The brochure, with its excellent illustrations, maps, diagrams and store of statistics, constitutes a most serviceable exposition of the port and its activities.

The accommodation provided and the facilities installed by the Board for public use are summarised as follows: "Since the Board of Commissioners of the Port assumed control of the public wharves in 1901, it has provided 7 miles of wharves, 5½ miles of which are covered with modern steel sheds; a terminal grain elevator having a storage capacity of 2,622,000 bushels; a cotton warehouse having a capacity of 461,856 high density bales; two special banana unloading wharves equipped with 12 mechanical banana unloaders having a total unloading capacity of 26,400 stems per hour; a two-storey green coffee wharf, having a storage capacity of approximately 385,000 bags of coffee, and many subsidiary and auxiliary facilities. The value of these properties is approximately $27,240,000, exclusive of land values.

Blyth Harbour Commission.

At the annual meeting of Blyth Harbour Commission, Mr. A. S. Witherington, a shipowner of Newcastle, was re-elected chairman, and Mr. Roland Lishman, a prominent Northumberland coal-owner, was elected deputy-chairman.

Presenting the annual report and accounts, Mr. Witherington said that the Commissioners' finances continued to suffer through war conditions. Coal shipments showed a small increase, but general trade had declined. There had been an improvement in revenue for the year, but expenditure had also shown a substantial increase, with the result that there was a deficit on the years working. Weather and other circumstances had adversely affected traffic on the ferries, on which there had been a loss of some £3,000.

London Dock Strike.

In connection with a serious dock strike at the Port of London, which occurred early in March, the Ministry of Labour has announced the holding of a joint enquiry by the Dock Labour Corporation, the employers and the trade unions concerned. The following terms of reference have been agreed upon: "To enquire into the circumstances of the recent stoppage of work in the London Docks and to report." The enquiry is in course of being held.

The following is the constitution of the Board of Inquiry:—

National Dock Labour Corporation: Lord Ammon, Mr. H. M. Barton and Mr. R. H. Jones.

London Port Employers: Sir Douglas Ritchie, Mr. W. E. Keville and Mr. R. Sneddon.

Trade Unions: Mr. Arthur Deakin, Mr. Arthur Bird and Mr. A. J. Archer.

Regent's Canal Dock.

As a result of the dredging operations recently carried out by the Grand Union Canal Company at the Regent's Canal Dock (reported in our issue of November last), the Company state that they are now able to accept ships of the following dimensions:

Maximum overall length, 315-ft.; Maximum overall beam, 46-ft.; Maximum overall draft, 19-ft. on **low neap tides,** 20-ft. on average tides and 22-ft. on Spring tides.

Traffic on British and Continental Canals.

The Parliamentary Secretary to the Ministry of War Transport recently gave the following figures of annual traffic on inland waterways in Great Britain and on certain European canals :—

About 7½ million tons of traffic a year is carried on the Manchester Ship Canal and 11¼ million tons on the other inland waterways in Great Britain. The traffic on the southern section of the Dortmund-Ems Canal (Bergeshovede-Batteln) is estimated to have increased from 1,000,000 tons a month before the war to 2,000,000 tons a month in June, 1944. The traffic passing Hasselt, on the Albert Canal, amounted to 3,500,000 tons in 1936.

Impending Developments at the Port of Baltimore.

An important programme of channel deepening and improvement works at the Port of Baltimore, U.S.A., awaits the approval of the United States Senate. New channels are proposed to accommodate ships of considerable draught. From the ocean to Port McHenry, there is to be an overall depth of 39-ft., instead of 35-37-ft. as originally designed. An anchorage area, 2,400-ft. by 1,200-ft., is to be provided south of the present River-view Anchorage. A new connecting channel, 400-ft. wide and 27-ft. deep, from the Cut-off Brewerton angle in the Main Channel to the Chesapeake and Delaware Canal, will save time and expense to ships in the overseas and Coastal trades. A channel, 200-ft. wide and 35-ft. deep is to be formed in Curtis Creek for the benefit of the industrial area there. The estimated total cost of the dredging programme is $2,388,000, with approximate annual maintenance charges of $57,000.

Curious War-time Dry Dock Experience.

It has recently been disclosed that during an air raid in October, 1941, a vessel undergoing repairs in a dry dock on Tyneside was thrown off the blocks on to her side, damaging and holing the vessel, simultaneously with the blowing away of a large portion of the dock side. By determined efforts the vessel was temporarily made watertight and, though listing heavily, was undocked and beached pending repairs to the dock structure, after which the vessel was once more laid on fresh keel blocks and the interrupted work resumed. The vessel was back in dock only four and a half days after the bomb fell.

Reinstatement of Port Workers.

The Ministry of Labour and National Service issued a notice early in January that under an Essential Work (Dock Labour) Order, 1945, which came into force of January, 22nd, port transport workers with reinstatement rights under the Reinstatement in Civil Employment Act, 1944, who, before going on war service, were in the regular employment of a port transport employer in a port where the Dock Labour Scheme is now operated by the National Dock Labour Corporation, are to be reinstated in the employment of that employer instead of in the employment of the Corporation.

Floating Fire Patrol on River Thames.

Throughout the last three years the *P.L.A. Monthly* reveals, a River Fire Patrol has operated on the Thames to give fire protection to barges in the river. With their waterside obligations, the Fire Service were not able to accept responsibility for watching the large number of barges tied up overnight at the numerous moorings on either side of the main river channel, and the Fire Watching and Fire Guard Orders laid no obligation on anybody for the fire watching of these barges. The cargoes consisted of foodstuffs, raw materials, etc., that had travelled thousands of miles to reach this country, and in many cases were irreplaceable. The Port Authority, therefore, took the initiative in organising a system of night patrol by river tugs ; later the Ministry of War Transport assumed financial responsibility for this scheme. The personnel of this Fire Guard Afloat were the tugmasters and crews who know every inch of the river and the idiosyncracies of its tides.

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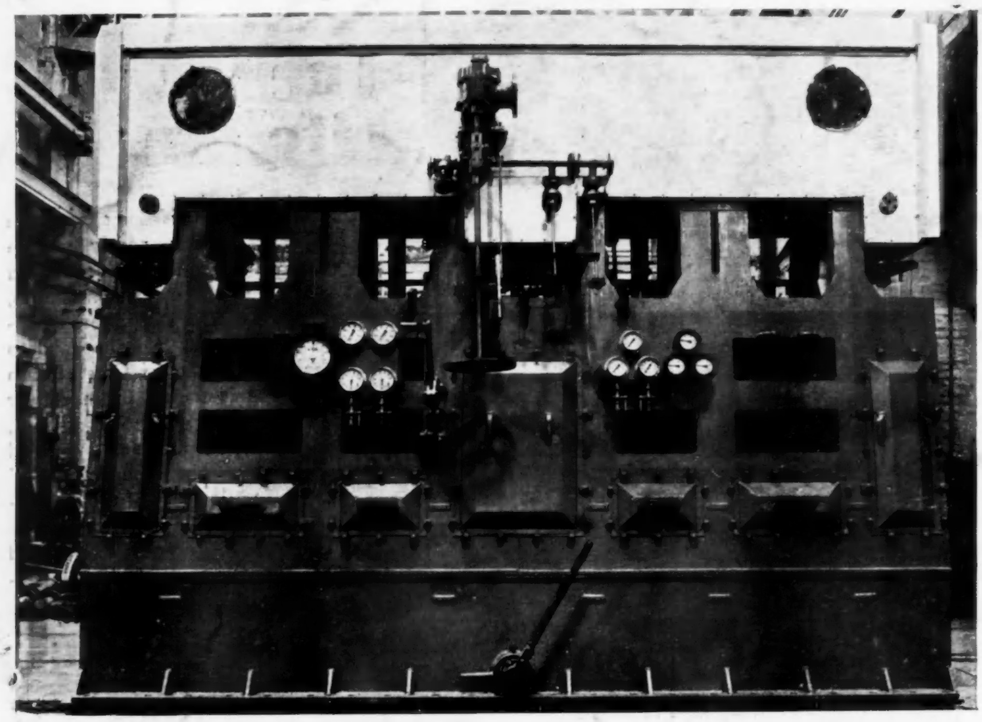

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